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VOL II

FIRE SUPPRESSION BY HALON 2402, VOLUME II OF II

M. PLUGGE, R.E. TAPSCOTT, H.D. BEESON, D. ZALLEN,
J.L. WALKER, P. CAMPBELL

NEW MEXICO ENGINEERING RESEARCH INSTITUTE
BOX 25, UNIVERSITY OF NEW MEXICO
ALBUQUERQUE NM 87131

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This Technical Report is divided into two Volumes. Volume I consists of the front matter and text while Volume II consists of Appendices A - J. Fire testing shows that, in outdoor applications, the fire extinguishment capability of Halon 2402 is superior to that of Halon 1211 and 1301. The increase in effectiveness is due to better agent application properties (Halon 2402 is ejected as a liquid), better fuel-inerting capacity (lower vapor pressure), and improved flame suppression (possibly resulting from the presence of two bromine atoms). An environmental assessment shows no environmentally unacceptable properties; however, toxicity during agent use could be problematical.

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PREFACE

This final report was prepared by the New Mexico Engineering Research Institute (NMERI), University of New Mexico, Box 25, Albuquerque, New Mexico 87131, under Contract F29601-84-C-0080 (Subtask 3.02), for the Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall Air Force Base, Florida 32403-6001, and Naval Air Systems Command, Department of the Navy, Washington, D.C. 20361-5510.

This is Volume II of a two-volume report. Volume II contains all of the appendix material, computer programs, data, instrument calibration, and the proposed military specification for Halon 2402. Volume I contains all of the text which includes testing, results, and conclusions.

NMERI scientists and engineers who contributed to testing and data interpretation in this project include Betty J. Humphrey, Mark L. Graham, Gerard A. Blahut, and J. Kent Newman. Special acknowledgment is due the project technicians, Susan H. Kellogg, Jimmy D. Watson, Jesse M. Parra, Dana R. Drake, Tracy A. Goss, Thomas M. Debevec, C. Tom Coulter, Bruce M. Willard, Brian D. McGill, Fwu-Lin Lii; Dr Ulrich Hollstein, Professor of Chemistry; and Dr Robert Royer, Research Associate.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This Technical Report has been reviewed and is approved for public release.

JOSEPH L. WALKER
Chief, Fire Technology Branch

LAWRENCE D. HOKANSON, Col, USAF
Director of Engineering and Services Laboratory

ROBERT R. COSTIGAN, Lt Col, USAF
Chief, Engineering Research Division

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APPENDIX A
TEST RESULTS

TABLE A-1. TEST 1 RESULTS, HEXANE, TEMPERATURE = 70 °F.

(1)	8 mL Hexane 2 mL 2402 20% 2402	Mixture ignited on first pass of torch and burned completely in 62 seconds.
(2)	7 mL Hexane 3 mL 2402	Mixture did not ignite on second pass of torch.
(3)	7.5 mL Hexane 2.5 mL 2402 25% 2402	Mixture did not ignite after second pass of torch, but was very close to ignition.
(4)	7.6 mL Hexane 2.4 mL 2402 24% 2402	Mixture ignited on first pass of torch and burned completely in 56 seconds. The halon lifted flame off fuel cup.
(5)	Same as #2	Evaporation test. Mixture was allowed to sit in open air for 5 minutes before attempting ignition. It ignited on first pass of torch and burned completely in 46 seconds.

TABLE A-2. TEST 2 RESULTS, ACETONE, TEMPERATURE = 70 °F.

(1)	8 mL Acetone 2 mL 2402 20% 2402	Mixture ignited on first pass and burned completely in 81 seconds.
(2)	7 mL Acetone 3 mL 2402 30% 2402	Mixture did not ignite.
(3)	7.5 mL Acetone 2.5 mL 2402 25% 2402	Mixture ignited on first pass of torch and burned completely in 82 seconds.
(4)	7.2 mL Acetone 2.8 mL 2402 28% 2402	Mixture ignited on second pass of torch but burned for only 12 seconds before extinguishing.
(5)	Same as #2	Evaporation Test. Mixture was allowed to sit in open air for 5 minutes before attempting ignition. Mixture ignited and burned completely in 72 seconds.

TABLE A-3. TEST 3 RESULTS, METHONAL, TEMPERATURE = 70 °F.

(1)	8 mL Methanol 2 mL 2402	Mixture did not ignite on second pass of torch.
(2)	8.5 mL Methanol 1.5 mL 2402 15% 2402	Mixture ignited on first pass of torch and burned completely in 127 seconds. Could smell 2402 burning.
(3)	8.4 mL Methanol 1.6 mL 2402 16% 2402	Mixture ignited on first pass of torch. At first the flame was small but it burned completely in 121 seconds.
(4)	8.2 mL Methanol 1.8 mL 2402 18% 2402	Mixture ignited on second pass of torch. The very small flame extinguished in 12 seconds.
(5)	Same as #1	Evaporation test. The mixture was allowed to sit in open air for 5 minutes. Mixture ignited on second pass of torch and burned completely in 118 seconds.

TABLE A-4. TEST 4 RESULTS, ETHANOL, TEMPERATURE = 70 °F.

(1)	8 mL Ethanol 2 mL 2402 29% 2402	Mixture did not ignite after two passes of torch.
(2)	8.6 mL Ethanol 1.4 mL 2402 14% 2402	Mixture did not ignite after two passes of torch.
(3)	9.0 mL Ethanol 1.0 mL 2402 10% 2402	Mixture did not ignite after two passes of torch.
(4)	9.5 mL Ethanol 0.5 mL 2402 5% 2402	Mixture did not ignite after two passes of torch.
(5)	9.7 mL Ethanol 0.3 mL 2402 3% 2402	Mixture ignited on first pass of torch and burned completely in 151 seconds.
(6)	Same as #4	Evaporation test. The mixture was allowed to sit for 5 minutes before trying to ignite. Mixture ignited on first pass of torch and burned completely in 140 seconds.

TABLE A-5. TEST 5 RESULTS, HEPTANE, TEMPERATURE = 70 °F.

(1)	8 mL Heptane 2 mL 2402 20% 2402	Mixture did not ignite.
(2)	9 mL Heptane 1 mL 2402 10% 2402	Mixture ignited on second pass of torch and burned completely in 85 seconds. The flame was lifted off fuel.
(3)	8.3 mL Heptane 1.5 mL 2402 15% 2402	Mixture did not ignite.
(4)	8.7 mL Heptane 1.3 mL 2402 13% 2402	Mixture did not ignite.
(5)	8.8 mL Heptane 1.2 mL 2402 12% 2402	Mixture did not ignite.
(6)	8.9 mL Heptane 1.1 mL 2402 11% 2402	Mixture ignited for 2 seconds after second pass of torch.
(7)	Same as #3	Evaporation test. Mixture allowed to sit for 5 minutes. Allowed to sit for another 5 minutes and ignited. Mixture burned completely in 80 seconds.

TABLE A-6. TEST 6 RESULTS, JP-4 JET FUEL, TEMPERATURE = 70 °F.

(1)	8 mL JP-4 2 mL 2402 20% 2402	Mixture did not ignite.
(2)	9 mL JP-4 1 mL 2402 10% 2402	Mixture did not ignite.
(3)	9.5 mL JP-4 0.5 mL 2402 5% 2402	Mixture ignited and burned completely in 145 seconds.
(4)	9.3 mL JP-4 0.7 mL 2402 7% 2402	Mixture ignited after three quick attempts and burned in 139 seconds.
(5)	9.2 mL JP-4 0.8 mL 2402 8% 2402	Mixture ignited after two attempts and burned in 145 seconds.
(6)	Same as #2	Mixture allowed to sit in open air for 5 minutes before first ignition try. It did not ignite and was allowed to sit for another 5 minutes at which time it did ignite. The mixture burned completely in 120 seconds.

TABLE A-7. TEST 7 RESULTS, JP-5 JET FUEL, TEMPERATURE = 70 °F.

(1)	8 mL JP-5 2 mL 2402 20% 2402	Flame was held on mixture for 5 seconds twice. Mixture did not ignite.
(2)	8.5 mL JP-5 1.5 mL 2402 15% 2402	Flame was held on mixture for 5 seconds twice. Mixture did not ignite.
(3)	9 mL JP-5 1 mL 2402 10% 2402	Flame was held on mixture for 5 seconds twice. Mixture did not ignite.
(4)	9.5 mL JP-5 0.5 mL 2402 5% 2402	Flame was held on mixture for 5 seconds twice. Mixture did not ignite.
(5)	9.75 mL JP-5 0.25 mL 2402 2.5% 2402	Flame was held on mixture for 5 seconds twice. Mixture did not ignite.
(6)	9.90 mL JP-5 0.10 mL 2402 1% 2402	Flame was held on mixture twice. No ignition first time. Second time, fuel ignited and burned completely.
(7)	Same as #5	Evaporation test. Mixture was allowed to sit in air for 5 minutes. At each attempt, the flame was touched twice. Did not ignite at 5, 10, and 15 minutes. Ignited at 20 minutes.

TABLE A-8. TEST 8 RESULTS, REGULAR GASOLINE, OCTANE 88, TEMPERATURE = 68 °F.

(1)	8 mL regular gasoline 2 mL 2402 20% 2402	Mixture ignited on first pass of torch and burned completely in 80 seconds.
(2)	7 mL regular gasoline 3 mL 2402 30% 2402	Mixture ignited on first pass of torch. Only the vapors ignited. The flame lifted off of fuel.
(3)	6.5 mL regular gasoline 3.5 mL 2402 35% 2402	Mixture did not ignite on first or second pass of torch.
(4)	6.8 mL regular gasoline 3.2 mL 2402 32% 2402	Mixture did not ignite on first or second pass of torch.
(5)	Same as #4	Evaporation test. The mixture was allowed to sit in open air. No ignition occurred at 5, 10, 15, or 20 minutes.

TABLE A-9. TEST 9 RESULTS, UNLEADED GASOLINE, OCTANE 87, TEMPERATURE = 70 °F.

(1)	8 mL unleaded gas 2 mL 2402 20% 2402	Mixture ignited on first pass of torch and burned in 85 seconds.
(2)	7 mL unleaded gas 3 mL 2402 30% 2402	Mixture ignited on second pass of torch. Only vapor ignited and burned for 15 seconds. Flame lifted off of fuel.
(3)	6.5 mL unleaded gas 3.5 mL 2402 35% 2402	Mixture did not ignite on first or second pass of torch.
(4)	6.8 mL unleaded gas 3.2 mL 2402 32% 2402	Mixture did not ignite on first or second pass of torch.
(5)	Same as #4	Evaporation test. The mixture was allowed to sit in open air. The mixture did not ignite at 5 or 10 minutes. It did ignite at 15 minutes and burned completely.

TABLE A-10. TEST 10 RESULTS, SUPER UNLEADED GASOLINE, OCTANE 90, TEMPERATURE = 70 °F.

(1)	8 mL super unleaded 2 mL 2402 20% 2402	Mixture ignited on first pass of torch and burned completely in 90 seconds.
(2)	7 mL super unleaded 3 mL 2402 30% 2402	Mixture ignited on second pass of torch. Only vapor ignited and burned for 5 seconds. Flame lifted off of fuel.
(3)	6.5 mL super unleaded 3.6 mL 2402	Mixture did not ignite on first or second pass of torch.
(4)	6.8 mL super unleaded 3.2 mL 2402 32% 2402	Mixture did not ignite on first or second pass of torch.
(5)	Same as #4	The mixture was allowed to sit in open air. Mixture did not ignite at 5 or 10 minutes. At 15 minutes, mixture ignited and burned completely.

TABLE A-11. TEST 11 RESULTS, MEDIUM-SCALE INERTION HOLDING, 9.75 mL JP-5, 2.5 mL 2402, 8 in^2 SURFACE AREA.

Minutes	
5	No ignition
10	No ignition
15	No ignition
20	No ignition
25	Mixture ignited

TABLE A-12. TEST 12 RESULTS, MEDIUM-SCALE INERTION HOLDING, 68 mL UNLEADED GASOLINE, 32 mL 2402, 8 in^2 SURFACE AREA.

Minutes	
5	No ignition
10	No ignition
15	No ignition
20	No ignition
25	No ignition
Hours	
1	No ignition
2	No ignition
3	No ignition
4	No ignition
5	No ignition
6	Ignition

TABLE A-13. TEST 13 RESULTS, MEDIUM-SCALE INERTION HOLDING, 54.4 mL UNLEADED GASOLINE, 25.6 mL 2402, 80 in^2 SURFACE AREA.

Minutes	
5	No ignition
10	No ignition
15	No ignition
20	Ignition

TABLE A-14. TEST 14 RESULTS, INERTION HOLDING UNLEADED, TEMPERATURE = 77 °F.

Initial mixture 80 mL unleaded / 3.2 mL 2402

Halon amount		Results
3.2 mL	3.8%	Ignition
9.0 mL	10.1%	Ignition
12.0 mL	13.0%	Ignition
16.0 mL	16.7%	Ignition, self-extinguishment in 12 seconds.
18.0 mL	18.4%	Ignition, self-extinguishment in 7 seconds. Water was present, started floating.
20.0 mL	20.0%	Ignition, self-extinguishment in 3 seconds. Water was floating on surface of fuel.
22.0 mL	21.6%	Ignition, self-extinguishment in 2 seconds. Fuel burned on lip of pan and did not touch the fuel surface.
24.0 mL	23.1%	Ignition in midair for less than 1 second.
26.0 mL	24.5%	Temporary ignition.
28.0 mL	25.9%	Inerted.

Inertion holding test

5 minutes inert
15 minutes inert
30 minutes inert
45 minutes inert
60 minutes inert
2 hours inert
3 hours inert
4 hours inert
5 hours inert
Next day
23 hours inert
24 hours inert
25 hours inert

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APPENDIX B

DEVELOPMENT OF ALGORITHM FOR COMPUTER PROGRAM "TRAJECTORY"

A. CALCULATIONS OF PHYSICAL PROPERTIES

A number of physical properties are needed to perform the computations. The means for obtaining these properties are first outlined and then the computational methods are described.

1. Heat of Vaporization

The droplet temperature will, generally, not be close to the wet-bulb temperature for Halon 2402 liquid in ambient air. It is assumed for simplification that no heat transfers from the interior of the drop to the surface, and that as the surface cools it supplies some of the heat needed for evaporation. This lowers the apparent value of g, the heat of vaporization, and the equilibrium temperature will be slightly higher than the true wet-bulb temperature.

At any temperature, λ may be estimated from a thermodynamic cycle. The value of λ at the true wet-bulb temperature is given by

$$\lambda^*_{wb} = \lambda_{117} + C_{p,liq}(117 - T_{wb}) - C_{p,vap}(117 - T_{wb}) \qquad \text{(B-1)}$$

where λ_{117} is the heat of vaporization at 117 °F, the boiling point of Halon 2402 at one atmosphere pressure; T_{wb} is the wet-bulb temperature; and $C_{p,liq}$ and $C_{p,vap}$ are the specific heats of liquid and gaseous Halon 2402. The heat of vaporization of Halon 2402 at its normal boiling point is 49.6 British thermal units/pound (Btu/lb). The specific heats are 0.166 Btu/(lb)(°F) for the liquid and 0.11 Btu/(lb)(°F) for the vapor. Solving for the heat of vaporization at the true wet-bulb temperature, one obtains

$$\lambda^*_{wb} = 49.6\ 0.166\ (117 - T_{wb}) - 0.11\ (117 - T_{wb}) \qquad \text{(B-2)}$$

or, combining terms,

$$\lambda^*_{wb} = 56.152 - 0.056\ T_{wb} \qquad \text{(B-3)}$$

2. The Pseudoheat of Vaporization and the Wet-Bulb Temperature

The true value of the heat of vaporization at the lower temperature is modified by the heat obtained from cooling the droplet surface from T_o, the initial liquid temperature, to T_{wb}. Given 1 pound of Halon 2402, a small amount, X, is evaporated by this extra heat.

$$X = C_{p,liq} (T_o - T_{wb})/\lambda_{wb} \tag{B-4}$$

The heat required to evaporate this additional amount of liquid is given by

$$Q = (1 - X)\lambda_{wb} \tag{B-5}$$

Substituting Equation (B-5) into Equation (B-4) gives,

$$Q = \lambda_{wb} - C_{p,liq} (T_o - T_{wb}) \tag{B-6}$$

and

$$Q = 56.152 + 0.11\ T_{wb} - 0.166\ T_o \tag{B-7}$$

3. Vapor Pressure

The vapor pressure of Halon 2402, p, is reported as 0.5 bar at 298 °K and 0.9 bar at 318 °K (Reference B-1), where 1 bar = 0.9869 atm. A plot of log p versus (1/T) gives a substantially straight line over short distances (Reference B-2).

$$\log_{10} p = a - b/T \tag{B-8}$$

For T in degrees Rankine and p in atmospheres, a = 3.752 and b = 2177 $^{o}R^{-1}$.

The mole fraction, y_i, of Halon 2402 vapor at the liquid/gas interface is equal to the ratio of the Halon 2402 vapor pressure to the total pressure, P. This ratio is also equal to the partial volume, v, of Halon 2402 divided by the total volume, V.

$$y_i = v/V = p/P \tag{B-9}$$

4. Approach Factor

The correction for the mutual diffusivity correlation for unicomponent diffusion (Reference B-3) is

$$\phi = [(1 - y) - (1 - y_i)]/\ln[(1 - y)/(1 - y_i)] \tag{B-10}$$

where ϕ is the approach factor (the relative velocity factor) and y and y_i respectively, the mole fractions of Halon 2402 at the interface and in bulk air. When the bulk air contains no Halon 2402 vapor, y = 0 and

$$\phi = y_i/\ln[1/(1 - y_i)] \tag{B-11}$$

5. Film Temperature

The properties of the stagnant film between the droplet interface and bulk air may be determined by appropriate averages. The film temperature, T_f, is an average of the wet-bulb and ambient air temperatures,

$$T_f = (T_{wb} + T_a)/2 \tag{B-12}$$

6. Gas Film Molecular Mass

The average molecular mass for the gas film is given by a weighted average of the molecular mass of air (M_{air} = 29) and of Halon 2402 (M_{2402} = 259.8).

$$M_{avg} = 259.8\ (y_i/2) + 29\ (1 - y_i/2) \tag{B-13}$$

7. Gas Film Density

The average density, ρ_f, of the stagnant gas film at 70 °F is also given by a weighted average of the densities of air (0.075 lb/ft^3) and Halon 2402 (0.672 lb/ft^3) at 70 °F.

$$\rho_{f,70} = 0.672\ (y_i/2) + 0.075\ (1 - y_i/2) \qquad \text{(B-14)}$$

$$\rho_{f,70} = 0.2985\ y_i + 0.075\ \text{lb/ft}^3 \qquad \text{(B-15)}$$

From the ideal gas law, at any film temperature, T_f (in °F),

$$\rho_{f,T} = [530/(460 + T_f)][0.2985\ y_i + 0.075]\ \text{lb/ft}^3 \qquad \text{(B-16)}$$

8. Gas Film Specific Heat

The average heat capacity of the gas film is determined assuming a linear relationship of heat capacity to weight fraction. The heat capacity changes slowly with temperature; therefore, constant values are used. The heat capacity per cubic foot is calculated using densities at 70 °F:

$$q_{70}(\text{Btu/°F}) = (y_i/2)(0.672)(0.11) + (1-y_i/2)(0.075)(0.25)$$

$$= 0.027585\ y_i + 0.01875 \qquad \text{(B-17)}$$

The weight, W_{70}, per cubic foot of gas at 70 °F is given by 0.2985 y_i + 0.075 as expressed in Equation (B-15). The average specific heat is, therefore, given by

$$C_{p,avg,gas} = q_{70}/W_{70} = (1.4712y_i + 1)/(15.92y_i + 4)\ \text{Btu/lb°F} \qquad \text{(B-18)}$$

9. Viscosity of Gas Film

The viscosity of the averaged gas film was determined as follows. Two points for the viscosity of air at two temperatures were taken from an alignment chart in Reference B-4. A linear relationship was assumed. The viscosity, μ, of Halon 2402 vapor was estimated from a method suggested by Reid and Sherwood (Reference B-5). This method depends on molecular weight, M, the critical pressure, P_c, and the critical temperature, T_c; and it varies with the reduced temperature, $T_r = T/T_c$, where all temperatures are expressed in Kelvin.

$$\mu = (6.3^{-4})(M^{1/2})(P_c^{2/3})(T_r^{3/2})/(T_c^{1/6})(T_r + 0.8) \qquad \text{(B-19)}$$

The critical temperature and pressure (Reference B-1) are 487.7 °K and 33.6 atm. The estimated viscosities are 0.0162 centipoise (cp) and 0.011 cp for air and Halon 2402 at 10 °F. The respective values at 100 °F are 0.0182 cp and 0.0133 cp. A linear function of viscosity with temperature was assumed to give the following equations for viscosity.

$$\mu_{air} = 0.0162 + (0.002)(T_f - 10)/90 \qquad \text{(B-20)}$$

$$\mu_{2402} = 0.011 + (0.0023)(T_f - 10)/90 \qquad \text{(B-21)}$$

The viscosities of gas mixtures may be estimated from the following equation (Reference B-6).

$$\mu_{avg} = [\mu_1 f_1(M_1^{1/2}) + \mu_2 f_2(M_2^{1/2})]/[f_1(M_1^{1/2}) + f_2(M_2^{1/2})] \qquad \text{(B-22)}$$

10. Thermal Conductivity of Gas Mixture

The thermal conductivity, k, of air at two temperatures was taken from Reference B-7 and a straight line through these points, $k_{air} = 0.0140$ at 32 °F and $k_{air} = 0.0184$ at 212 °F in units of Btu-ft/(ft^2)(h)(°F) at 32 °F, was calculated.

$$k_{air} = 0.014 + (2.44 \times 10^{-5})(T_f - 32\ ^\circ F) \qquad \text{(B-23)}$$

The thermal conductivity of Halon 2402 gas can be approximated from the heat capacity and viscosity. An estimate for k_{2402} was taken from Reference B-8 for two different viscosities, representing two temperatures. The data were k_{2402} = 0.0031 at 10 °F and k_{2402} = 0.0039 at 100 °F in units of Btu-ft/(ft)(h)(°F). A straight line was fit to these two values to give

$$k_{2402} = 0.0031 + (8.89 \times 10\text{-}6)(T_f - 10\ °F) \qquad (B\text{-}24)$$

The thermal conductivity, K, of a mixture of two gases can be calculated (Reference B-9) from

$$K = 0.5\ (k_{sm} + k_{rm}) \qquad (B\text{-}25)$$

where

$$k_{sm} = x_1k_1 + x_2k_2 = k_{2402}(y_i/2) + k_{air}(1 - y_i/2) \qquad (B\text{-}26)$$

and

$$1/k_{rm} = x_1/k_1 + x_2/k_2 = (y_i/2)/k_{2402} + (1 - y_i/2)/k_{air} \qquad (B\text{-}27)$$

11. Mutual Diffusivity of Air/Halon 2402 Mixtures

The diffusivity, D_v, of Halon 2402 in air is given as 0.05 cm^2/s = 0.19375 ft^2/h at 77 °F and 1 atmosphere pressure (Reference B-1). If diffusivity is expressed in molal units, $\rho_m D_v$ is identical to D_m, where ρ_m is the molal density in lb-mol/ft^3, D_m is the molar diffusivity in lb-mol/(ft)(h), and D_v is the diffusivity expressed in ft^2/h (Reference B-10). If ρ is the density in lb/ft^3 and M_{avg} is the average molecular weight in lb/lb-mol, then $\rho_m M_{avg} = \rho$. Therefore,

$$\rho_m M_{avg} D_v = \rho D_v = M_{avg} D_m \qquad (B\text{-}28)$$

It is not necessary to use the variation of D_v (or D_m) with temperature when the Schmidt number, $\mu/\rho D_v$, is used. This group varies only slightly over a moderate temperature range. D_v varies approximately as $T_{abs}^{3/2}$

and D_m varies as $T_{abs}^{3/2}$. Since the estimate of evaporation rate uses D_v without μ in the first factor, D_v or D_m must be used with a temperature dependence estimate. A more accurate estimating method is (Reference B-11)

$$D_m = \rho_{77}(D_{v,77}/M_{avg})[(T_f + 460)/537]^{3/2} \quad \text{(B-29)}$$

where

$$\rho_{77} = (530/537)(0.2985\ y_i + 0.07\text{C})$$

This gives

$$D_m = (4.5869\ y_i + 1.1525)(T_f + 460)^{3/2}/M_{avg}(10^6) \quad \text{(B-30)}$$

B. CALCULATION PROCEDURES

1. Relation of Heat and Mass Transfer

The similarity between the mechanisms for heat and mass transfer is expressed as the Colburn analogy (Reference B-12). This analogy states that the ratio between the dimensionless heat and mass transfer groups remains constant over a fairly wide range of Reynolds number conditions. Since heat must be transferred to evaporate and warm the liquid, there is a balance between mass transferred from the liquid surface and the heat transmitted to it when the system is at equilibrium. Dimensional analysis has been used to identify the factors affecting heat and mass transfer rates and to arrange them into dimensionless groups. Experimental data is used to evaluate an exponent representing a slope on a log-log plot. For heat transfer,

$$h_y/C_pG = (K/C_p\mu)^a \quad \text{(B-31)}$$

and

$$k_yM_{avg}/G = (D_mM_{avg}/\mu)^b \quad \text{(B-32)}$$

where h_y is the heat transfer coefficient in Btu/(h)(ft^2)(°F), k_y is the mass transfer coefficient in lb-mol/(h)(ft^2)(change in mole fraction), G is the mass flux in lb/(h)(ft^2), and a and b are constants to be determined.

The Colburn analogy states that the ratio of heat to mass transfer is expressed as

$$(h_y/C_p G)/(M_{avg} k_y/G) = [(\mu/D_m M_{avg})/(C_p \mu/K)]^m \quad (B\text{-}33)$$

or, rearranging,

$$h_y/k_y = M_{avg} C_p [(\mu/D_m M_{avg})/(C_p \mu/K)]^m \quad (B\text{-}34)$$

The value of m is usually near 2/3, and all quantities are estimated for the average gas film.

2. Equating Heat and Mass Balances

The rate of mass transfer from the droplet surface is

$$N_a = (k_y/\phi)(y_i - y)A \quad (B\text{-}35)$$

where N_a is expressed in lb-mol/h and A is the liquid area in ft^2.

The heat needed to evaporate the liquid Halon 2402 at the pseudo-wet-bulb temperature (using the modified value of the heat of vaporization) and to heat the vapor to the average gas film temperature is

$$q_1 = M_{2402} N_a [\lambda + C_{p,vap}(T_a - T_{wb})] \quad (B\text{-}36)$$

The rate of heat transfer is equal to

$$q_2 = h_y (T_a - T_{wb}) A \quad (B\text{-}37)$$

Equating q_1 and q_2 and substituting for the value of N_a gives, at equilibrium,

$$M_{2402}(k_y/\phi)(y_i - y)A[\lambda + C_{p,vap}(T_f - T_{wb})] = h_y (T_a - T_{wb})A \quad (B\text{-}38)$$

Since T_f is assumed equal to $(T_c + T_{wb})/2$, then

$$T_f - T_{wb} = (T_a - T_{wb})/2 \quad (B\text{-}39)$$

Rearranging gives

$$h_y/k_y = (M_{2402}/\phi)[\lambda + C_{p,vap}(T_a - T_{wb})/2](y_i - y)/(T_a - T_{wb}) \qquad (B\text{-}40)$$

and

$$T_{wb} = T_a - 2M_{2402}\lambda(y_i - y)/[2_\phi h_y/k_y - M_{2402}C_{p,vap}(y_i - y)] \qquad (B\text{-}41)$$

3. Calculation of the Wet-Bulb Temperature

On the right side of equation B-40 only T_{wb} is unknown. The left side is evaluated using Equation (B-34). Over a narrow temperature range, neither of the dimensionless quantities in Equation (B-34) change very much. For increased accuracy and with a computer available, however, it is desirable to calculate film properties at each temperature. The order of the calculation is completed as follows: (a) start with a reasonable value of T_{wb}, (b) use the equations in this section to determine average film properties, (c) calculate h_y/k_y from Equation (B-34), (d) calculate T_{wb} from Equation (B-41). A new guessed value of T_{wb} is obtained by averaging the original guessed and calculated values. This is repeated until convergence occurs.

Once a wet-bulb temperature is estimated, it is assumed that the value does not change over a wide range of droplet slip velocities relative to the bulk air. Therefore, the average film temperature properties calculated in in the last trial are used to estimate all evaporation rates.

4. Calculation of Evaporation Rate as a Function of Slip Velocity

From experimental data (Reference B-13),

$$k_y = (2D_v\rho/RTd)[1 + 0.276(du\rho/\mu)^{1/2}(\mu/\rho D_v)^{1/3}] \qquad (B\text{-}42)$$

where u is the slip velocity in ft/h, ρ is the average gas film density in lb/ft^3, μ is the average film viscosity in lb/(h)(ft), d is the droplet diameter in feet, D_v has units of ft^2/h, k_y is expressed in lb-mol/(h)(ft^2), and R is th gas constant.

Since D_m has already been calculated, a substitution can be made based on the identity $\rho D_v = M_{avg} D_m$. In addition, from the ideal gas law, $PV = (w/M_{avg})RT$ and $P/RT = (w/V)(1/M_{avg}) = \rho/M_{avg}$. This gives

$$k_y = 2D_m/d[1 + 0.276(du\rho/\mu)^{1/2}(\mu/M_{avg}D_m)^{1/3}] \quad (B-43)$$

From Equation (B-35), the evaporation rate of Halon 2402, is given by

$$M_{2402}N_a = (M_{2402}K_y/\phi)(y_i - y)A \quad (B-44)$$

where A is the droplet area in ft^2, ϕ is the approach factor, y is the concentration of Halon 2402 in the bulk air (assumed equal to zero in the simplest case), and y_i is the mole fraction of Halon 2402 in the air at the droplet interface.

5. Calculation of the Input to the Trajectory Computer Program

The weight of a drop of liquid is equal to

$$w = (4/3)\pi(d/2)^3\rho_{liq} = (\pi/6)d^3\rho_{liq} \quad (B-45)$$

and, the area of the droplet is

$$A = 4\pi(d/2)^2 = \pi d^2 \quad (B-46)$$

From Equation (B-44), the evaporation rate with y = 0 is

$$\Delta w/\Delta t = 259.8(k_y A)\ \ln[1/(1 - y_i)] \quad (B-47)$$

The new weight after a time t is equal to $w_o - t(\Delta w/\Delta t)$ and the new diameter is equal to $d = (6w/\pi\rho_{liq})^{1/3}$. For $\rho_{liq} = 135.47\ lb/ft^3$,

$$d = (0.014098w)^{1/3}\ ft \quad (B-48)$$

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B-7. McCabe and Smith, op. cit., Appendix 10.

B-8. Reid and Sherwood, op. cit., p. 227.

B-9. Reid and Sherwood, op. cit., p. 241.

B-10. **Chemical Engineers' Handbook**, op. cit., p. 539.

B-11. McCabe and Smith, op. cit., p. 617.

B-12. McCabe and Smith, op. cit., pp. 845-847.

B-13. **Chemical Engineers' Handbook**, op. cit., p. 547.

APPENDIX C

OUTPUT DATA AND GRAPHS
FROM COMPUTER PROGRAM "TRAJECTORY"

TABLE C-1. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.05 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .0500
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 0.
Time step (sec): .010

Time	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99925	.99775	.4	4.0
.02	.99850	.99552	.9	4.0
.03	.99777	.99331	1.3	4.0
.04	.99703	.99113	1.7	4.0
.05	.99631	.98896	2.1	4.0
.06	.99559	.98682	2.5	3.9
.07	.99487	.98470	2.9	3.9
.08	.99416	.98259	3.3	3.9
.09	.99346	.98051	3.7	3.9
.10	.99276	.97844	4.1	3.8
.11	.99207	.97639	4.5	3.8
.12	.99138	.97436	4.8	3.8
.13	.99069	.97234	5.2	3.7
.14	.99001	.97034	5.5	3.7
.15	.98934	.96836	5.9	3.7
.16	.98867	.96639	6.2	3.6
.17	.98800	.96443	6.6	3.6
.18	.98734	.96249	6.9	3.5
.19	.98668	.96057	7.2	3.5
.20	.98602	.95865	7.6	3.4
.21	.98537	.95675	7.9	3.4
.22	.98472	.95487	8.2	3.3
.23	.98408	.95299	8.5	3.2
.24	.98344	.95113	8.8	3.2
.25	.98280	.94928	9.1	3.1
.26	.98217	.94744	9.4	3.0
.27	.98153	.94562	9.7	3.0
.28	.98090	.94380	10.0	2.9
.29	.98028	.94199	10.3	2.8
.30	.97966	.94020	10.5	2.7
.31	.97903	.93841	10.8	2.7
.32	.97842	.93664	11.1	2.6
.33	.97780	.93487	11.4	2.5
.34	.97719	.93311	11.6	2.4
.35	.97658	.93137	11.9	2.3
.36	.97597	.92963	12.2	2.2
.37	.97536	.92789	12.4	2.1
.38	.97476	.92617	12.7	2.0
.39	.97416	.92445	12.9	2.0
.40	.97356	.92275	13.2	1.9
.41	.97296	.92105	13.4	1.8

.42	.97236	.91935	13.6	1.6
.43	.97177	.91767	13.9	1.5
.44	.97117	.91599	14.1	1.4
.45	.97058	.91431	14.4	1.3
.46	.96999	.91265	14.6	1.2
.47	.96940	.91098	14.8	1.1
.48	.96881	.90933	15.0	1.0
.49	.96823	.90768	15.3	.9
.50	.96764	.90604	15.5	.8
.51	.96706	.90440	15.7	.6
.52	.96648	.90276	15.9	.5
.53	.96590	.90114	16.1	.4
.54	.96531	.89951	16.3	.3
.55	.96474	.89789	16.5	.1
.56	.96416	.89628	16.7	.0
.57	.96358	.89467	17.0	-.1

TABLE C-2. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99972	.99922	.4	4.0
.02	.99948	.99845	.9	4.0
.03	.99922	.99768	1.3	4.0
.04	.99897	.99691	1.8	4.0
.05	.99871	.99614	2.2	4.0
.06	.99846	.99538	2.6	3.9
.07	.99821	.99463	3.0	3.9
.08	.99795	.99388	3.5	3.9
.09	.99770	.99313	3.9	3.9
.10	.99745	.99238	4.3	3.8
.11	.99720	.99164	4.7	3.8
.12	.99696	.99090	5.1	3.8
.13	.99671	.99016	5.5	3.7
.14	.99646	.98943	5.9	3.7
.15	.99622	.98870	6.3	3.7
.16	.99597	.98797	6.7	3.6
.17	.99573	.98725	7.1	3.6
.18	.99549	.98653	7.4	3.5
.19	.99525	.98581	7.8	3.4
.20	.99501	.98509	8.2	3.4
.21	.99476	.98438	8.6	3.3
.22	.99453	.98367	8.9	3.3
.23	.99429	.98296	9.3	3.2
.24	.99405	.98225	9.7	3.1
.25	.99381	.98155	10.0	3.1
.26	.99357	.98085	10.4	3.0
.27	.99334	.98015	10.8	2.9
.28	.99310	.97945	11.1	2.8
.29	.99287	.97876	11.5	2.7
.30	.99263	.97807	11.8	2.7
.31	.99240	.97738	12.1	2.6
.32	.99217	.97669	12.5	2.5
.33	.99194	.97600	12.8	2.4
.34	.99170	.97532	13.2	2.3
.35	.99147	.97464	13.5	2.2
.36	.99124	.97396	13.8	2.1
.37	.99101	.97328	14.2	2.0
.38	.99078	.97260	14.5	1.9
.39	.99055	.97193	14.8	1.8
.40	.99033	.97126	15.1	1.7
.41	.99010	.97059	15.4	1.6

.42	.98987	.96993	15.8	1.5
.43	.98964	.96925	16.1	1.3
.44	.98942	.96858	16.4	1.2
.45	.98919	.96792	16.7	1.1
.46	.98896	.96725	17.0	1.0
.47	.98874	.96659	17.3	.9
.48	.98851	.96593	17.6	.7
.49	.98829	.96527	17.9	.6
.50	.98806	.96461	18.2	.5
.51	.98784	.96395	18.5	.3
.52	.98761	.96330	18.8	.2
.53	.98739	.96264	19.1	.1
.54	.98717	.96199	19.4	-.1

TABLE C-3. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.20 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .2000 Ambient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99991	.99973	.4	4.0
.02	.99982	.99946	.9	4.0
.03	.99973	.99919	1.3	4.0
.04	.99964	.99892	1.8	4.0
.05	.99955	.99865	2.2	4.0
.06	.99946	.99838	2.7	3.9
.07	.99937	.99812	3.1	3.9
.08	.99928	.99785	3.5	3.9
.09	.99919	.99758	4.0	3.9
.10	.99911	.99732	4.4	3.8
.11	.99902	.99705	4.8	3.8
.12	.99893	.99679	5.2	3.8
.13	.99884	.99653	5.7	3.7
.14	.99875	.99626	6.1	3.7
.15	.99867	.99600	6.5	3.6
.16	.99858	.99574	6.9	3.6
.17	.99849	.99548	7.3	3.5
.18	.99840	.99522	7.8	3.5
.19	.99832	.99496	8.2	3.4
.20	.99823	.99470	8.6	3.4
.21	.99814	.99444	9.0	3.3
.22	.99806	.99418	9.4	3.2
.23	.99797	.99392	9.8	3.2
.24	.99788	.99366	10.2	3.1
.25	.99780	.99340	10.6	3.0
.26	.99771	.99314	11.0	3.0
.27	.99762	.99289	11.4	2.9
.28	.99754	.99263	11.8	2.8
.29	.99745	.99237	12.2	2.7
.30	.99737	.99212	12.6	2.6
.31	.99728	.99186	13.0	2.5
.32	.99719	.99161	13.4	2.4
.33	.99711	.99135	13.7	2.3
.34	.99702	.99110	14.1	2.2
.35	.99694	.99084	14.5	2.1
.36	.99685	.99059	14.9	2.0
.37	.99677	.99034	15.3	1.9
.38	.99668	.99008	15.7	1.8
.39	.99660	.98983	16.0	1.7
.40	.99651	.98958	16.4	1.6
.41	.99643	.98932	16.8	1.5

.42	.99634	.98907	17.2	1.3
.43	.99626	.98882	17.5	1.2
.44	.99617	.98857	17.9	1.1
.45	.99609	.98832	18.3	.9
.46	.99601	.98807	18.6	.8
.47	.99592	.98781	19.0	.7
.48	.99584	.98756	19.4	.5
.49	.99575	.98731	19.7	.4
.50	.99567	.98706	20.1	.3
.51	.99558	.98681	20.4	.1
.52	.99550	.98656	20.8	.0

TABLE C-4. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.25 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .2500
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 0.
Time step (sec): .010

Time	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99994	.99981	.4	4.0
.02	.99987	.99961	.9	4.0
.03	.99981	.99942	1.3	4.0
.04	.99974	.99923	1.8	4.0
.05	.99968	.99904	2.2	4.0
.06	.99962	.99885	2.7	3.9
.07	.99955	.99866	3.1	3.9
.08	.99949	.99847	3.5	3.9
.09	.99942	.99828	4.0	3.9
.10	.99936	.99809	4.1	3.8
.11	.99930	.99790	4.8	3.8
.12	.99923	.99771	5.3	3.8
.13	.99917	.99752	5.7	3.7
.14	.99911	.99733	6.1	3.7
.15	.99905	.99714	6.6	3.6
.16	.99898	.99695	7.0	3.6
.17	.99892	.99676	7.4	3.5
.18	.99886	.99658	7.8	3.5
.19	.99880	.99639	8.2	3.4
.20	.99873	.99620	8.7	3.4
.21	.99867	.99602	9.1	3.3
.22	.99861	.99583	9.5	3.2
.23	.99855	.99564	9.9	3.2
.24	.99848	.99546	10.3	3.1
.25	.99842	.99527	10.7	3.0
.26	.99836	.99509	11.1	2.9
.27	.99830	.99490	11.5	2.9
.28	.99824	.99472	11.9	2.8
.29	.99817	.99453	12.4	2.7
.30	.99811	.99435	12.8	2.6
.31	.99805	.99416	13.2	2.5
.32	.99799	.99398	13.6	2.4
.33	.99793	.99379	14.0	2.3
.34	.99786	.99361	14.3	2.2
.35	.99780	.99342	14.7	2.1
.36	.99774	.99324	15.1	2.0
.37	.99768	.99306	15.5	1.9
.38	.99762	.99287	15.9	1.8
.39	.99756	.99269	16.3	1.7
.40	.99750	.99251	16.7	1.5
.41	.99743	.99232	17.1	1.4

.42	.99737	.99214	17.5	1.3
.43	.99731	.99196	17.9	1.2
.44	.99725	.99178	18.2	1.0
.45	.99719	.99159	18.6	.9
.46	.99713	.99141	19.0	.8
.47	.99707	.99123	19.4	.6
.48	.99701	.99105	19.8	.5
.49	.99695	.99086	20.1	.3
.50	.99688	.99068	20.5	.2
.51	.99682	.99050	20.9	.1
.52	.99676	.99032	21.3	-.1

TABLE C-5. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 15 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 15.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99971	.99922	.4	4.1
.02	.99948	.99845	.9	4.2
.03	.99923	.99768	1.3	4.3
.04	.99897	.99691	1.7	4.4
.05	.99872	.99615	2.1	4.5
.06	.99846	.99540	2.5	4.6
.07	.99821	.99464	2.9	4.7
.08	.99796	.99389	3.3	4.8
.09	.99771	.99315	3.7	4.9
.10	.99746	.99241	4.1	5.0
.11	.99722	.99167	4.5	5.0
.12	.99697	.99094	4.9	5.1
.13	.99673	.99021	5.3	5.2
.14	.99648	.98949	5.7	5.2
.15	.99624	.98877	6.1	5.3
.16	.99600	.98805	6.5	5.3
.17	.99576	.98734	6.8	5.4
.18	.99552	.98663	7.2	5.4
.19	.99528	.98592	7.6	5.5
.20	.99505	.98521	7.9	5.5
.21	.99481	.98451	8.3	5.6
.22	.99458	.98382	8.7	5.6
.23	.99434	.98313	9.0	5.6
.24	.99411	.98243	9.4	5.6
.25	.99388	.98174	9.7	5.7
.26	.99365	.98106	10.1	5.7
.27	.99341	.98037	10.4	5.7
.28	.99319	.97970	10.7	5.7
.29	.99296	.97902	11.1	5.7
.30	.99273	.97834	11.4	5.7
.31	.99250	.97767	11.8	5.7
.32	.99227	.97700	12.1	5.7
.33	.99205	.97634	12.4	5.7
.34	.99182	.97567	12.8	5.7
.35	.99160	.97501	13.1	5.7
.36	.99138	.97435	13.4	5.7
.37	.99115	.97370	13.7	5.7
.38	.99093	.97304	14.0	5.7
.39	.99071	.97239	14.4	5.6
.40	.99049	.97174	14.7	5.6
.41	.99027	.97109	15.0	5.6

.42	.99005	.97044	15.3	5.5
.43	.98983	.96980	15.6	5.5
.44	.98961	.96916	15.9	5.5
.45	.98939	.96852	16.2	5.4
.46	.98918	.96788	16.5	5.4
.47	.98896	.96724	16.8	5.3
48	.98874	.96661	17.1	5.3
.49	.98853	.96597	17.4	5.2
.50	.98831	.96531	17.7	5.2
.51	.98810	.96471	18.0	5.1
.52	.98788	.96408	18.3	5.1
.53	.98767	.96346	18.6	5.0
.54	.98745	.96283	18.8	4.9
.55	.98724	.96221	19.1	4.9
.56	.98703	.96158	19.4	4.8
.57	.98681	.96096	19.7	4.7
.58	.98660	.96034	20.0	4.6
.59	.98639	.95972	20.2	4.6
.60	.98618	.95910	20.5	4.5
.61	.98597	.95849	20.8	4.4
.62	.98576	.95787	21.1	4.3
.63	.98554	.95726	21.3	4.2
.64	.98533	.95664	21.6	4.1
.65	.98512	.95603	21.9	4.0
.66	.98491	.95542	22.1	3.9
.67	.98470	.95481	22.4	3.8
.68	.98449	.95420	22.7	3.7
.69	.98428	.95359	22.9	3.6
.70	.98407	.95298	23.2	3.5
.71	.98386	.95237	23.4	3.4
.72	.98365	.95176	23.7	3.3
.73	.98344	.95115	23.9	3.2
.74	.98324	.95055	24.2	3.0
.75	.98303	.94994	24.4	2.9
.76	.98282	.94933	24.7	2.8
.77	.98261	.94873	24.9	2.7
.78	.98240	.94813	25.2	2.6
.79	.98219	.94752	25.4	2.4
.80	.98198	.94692	25.7	2.3
.81	.98177	.94631	25.9	2.1
.82	.98157	.94571	26.1	2.0
.83	.98136	.94511	26.4	1.9
.84	.98115	.94451	26.6	1.7
.85	.98094	.94390	26.8	1.6
.86	.98073	.94330	27.1	1.4
.87	.98052	.94270	27.3	1.3
.88	.98031	.94210	27.5	1.1
.89	.98011	.94150	27.8	1.0
.90	.97990	.94089	28.0	.8
.91	.97969	.94029	28.2	.6
.92	.97948	.93969	28.5	.5
.93	.97927	.93909	28.7	.3
.94	.97906	.93849	28.9	.1
.95	.97885	.93789	29.1	.0

TABLE C-6. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 30 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 30.
Time step (sec): .010

Time sec	b/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99974	.99922	.4	4.2
.02	.99948	.99845	.8	4.4
.03	.99923	.99768	1.2	4.7
.04	.99897	.99692	1.5	4.9
.05	.99872	.99616	1.9	5.1
.06	.99847	.99540	2.3	5.3
.07	.99822	.99466	2.6	5.4
.08	.99797	.99391	3.0	5.6
.09	.99772	.99317	3.4	5.8
.10	.99747	.99244	3.7	6.0
.11	.99723	.99171	4.1	6.2
.12	.99699	.99099	4.4	6.3
.13	.99674	.99026	4.8	6.5
.14	.99650	.98955	5.1	6.6
.15	.99626	.98883	5.5	6.8
.16	.99603	.98813	5.8	6.9
.17	.99579	.98742	6.1	7.1
.18	.99555	.98672	6.5	7.2
.19	.99532	.98603	6.8	7.4
.20	.99509	.98534	7.1	7.5
.21	.99486	.98465	7.4	7.6
.22	.99463	.98396	7.8	7.8
.23	.99440	.98329	8.1	7.9
.24	.99417	.98261	8.4	8.0
.25	.99394	.98193	8.7	8.1
.26	.99371	.98126	9.0	8.2
.27	.99349	.98060	9.3	8.3
.28	.99327	.97994	9.7	8.4
.29	.99304	.97928	10.0	8.5
.30	.99282	.97862	10.3	8.6
.31	.99260	.97797	10.6	8.7
.32	.99238	.97732	10.9	8.8
.33	.99216	.97667	11.2	8.8
.34	.99194	.97603	11.5	8.9
.35	.99173	.97539	11.8	9.0
.36	.99151	.97475	12.0	9.1
.37	.99130	.97412	12.3	9.1
.38	.99108	.97349	12.6	9.2
.39	.99087	.97286	12.9	9.2
.40	.99066	.97223	13.2	9.3
.41	.99045	.97161	13.5	9.3

.42	.99023	.97099	13.8	9.4
.43	.99002	.97037	14.0	9.4
.44	.98981	.96976	14.2	9.5
.45	.98961	.96914	14.4	9.5
.46	.98940	.96853	14.6	9.5
.47	.98919	.96792	15.1	9.6
.48	.98898	.96732	15.4	9.6
.49	.98878	.96671	15.7	9.6
.50	.98857	.96611	15.9	9.6
.51	.98837	.96551	16.2	9.6
.52	.98817	.96491	16.5	9.7
.53	.98796	.96432	16.7	9.7
.54	.98776	.96373	17.0	9.7
.55	.98756	.96313	17.3	9.7
.56	.98736	.96254	17.5	9.7
.57	.98715	.96196	17.8	9.7
.58	.98695	.96137	18.0	9.7
.59	.98675	.96078	18.3	9.7
.60	.98655	.96020	18.5	9.6
.61	.98635	.95962	18.8	9.6
.62	.98616	.95904	19.0	9.6
.63	.98596	.95846	19.3	9.6
.64	.98576	.95788	19.5	9.6
.65	.98556	.95731	19.8	9.5
.66	.98536	.95673	20.0	9.5
.67	.98517	.95616	20.3	9.5
.68	.98497	.95558	20.5	9.4
.69	.98477	.95501	20.7	9.4
.70	.98458	.95444	21.0	9.3
.71	.98438	.95387	21.2	9.3
.72	.98418	.95330	21.5	9.2
.73	.98399	.95271	21.7	9.2
.74	.98379	.95217	21.9	9.1
.75	98360	.95160	22.2	9.1
.76	.98340	.95104	22.4	9.0
.77	.98321	.95047	22.6	8.9
.78	.98302	.94991	22.9	8.9
.79	.98282	.94934	23.1	8.8
.80	.98263	.94878	23.4	8.7
.81	.98243	.94822	23.6	8.7
.82	.98224	.94765	23.8	8.6
.83	.98204	.94709	24.0	8.5
.84	.98185	.94653	24.2	8.4
.85	.98166	.94597	24.4	8.3
.86	.98146	.94541	24.6	8.2
.87	.98127	.94485	24.9	8.1
.88	.98107	.94429	25.1	8.0
.89	.98088	.94373	25.3	8.0
.90	.98068	.94317	25.5	7.9
.91	.98049	.94260	25.7	7.8
.92	.98030	.94204	25.9	7.6
.93	.98010	.94148	26.1	7.5
.94	.97991	.94092	26.3	7.4
.95	.97971	.94036	26.6	7.3

.96	.97952	.93980	26.8	7.2
.97	.97932	.93924	27.0	7.1
.98	.97913	.93868	27.2	6.9
.99	.97893	.93812	27.4	6.8
1.00	.97874	.93755	27.6	6.7
1.01	.97854	.93699	27.8	6.6
1.02	.97834	.93643	28.0	6.4
1.03	.97815	.93587	28.2	6.3
1.04	.97795	.93530	28.4	6.2
1.05	.97776	.93474	28.6	6.0
1.06	.97756	.93418	28.8	5.9
1.07	.97736	.93361	29.0	5.7
1.08	.97716	.93305	29.2	5.6
1.09	.97697	.93248	29.4	5.4
1.10	.97677	.93192	29.6	5.3
1.11	.97657	.93135	29.8	5.1
1.12	.97637	.93078	29.9	5.0
1.13	.97618	.93022	30.1	4.8
1.14	.97598	.92965	30.3	4.7
1.15	.97578	.92908	30.5	4.5
1.16	.97558	.92851	30.7	4.3
1.17	.97538	.92794	30.9	4.2
1.18	.97518	.92737	31.1	4.0
1.19	.97498	.92680	31.2	3.8
1.20	.97478	.92623	31.4	3.6
1.21	.97458	.92565	31.6	3.5
1.22	.97438	.92508	31.8	3.3
1.23	.97417	.92451	32.0	3.1
1.24	.97397	.92393	32.1	2.9
1.25	.97377	.92336	32.3	2.7
1.26	.97357	.92278	32.5	2.6
1.27	.97336	.92220	32.7	2.4
1.28	.97316	.92162	32.9	2.2
1.29	.97296	.92105	33.0	2.0
1.30	.97275	.92047	33.2	1.8
1.31	.97255	.91989	33.4	1.6
1.32	.97235	.91931	33.5	1.4
1.33	.97214	.91873	33.7	1.2
1.34	.97194	.91815	33.9	1.0
1.35	.97173	.91756	34.0	.8
1.36	.97152	.91698	34.2	.6
1.37	.97132	.91640	34.4	.3
1.38	.97111	.91581	34.5	.1
1.39	.97090	.91523	34.7	-.1

TABLE C-7. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 45 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 45.
Nozzle height above ground (ft): 1.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99974	.99922	.3	4.3
.02	.99948	.99845	.6	4.6
.03	.99923	.99768	.9	4.9
.04	.99897	.99692	1.2	5.2
.05	.99872	.99616	1.6	5.5
.06	.99847	.99541	1.9	5.8
.07	.99822	.99467	2.2	6.1
.08	.99797	.99393	2.5	6.3
.09	.99773	.99319	2.7	6.6
.10	.99748	.99246	3.0	6.9
.11	.99724	.99174	3.3	7.1
.12	.99700	.99102	3.6	7.4
.13	.99676	.99031	3.9	7.6
.14	.99652	.98960	4.2	7.9
.15	.99628	.98889	4.5	8.1
.16	.99605	.98819	4.7	8.3
.17	.99582	.98750	5.0	8.6
.18	.99558	.98681	5.3	8.8
.19	.99535	.98612	5.5	9.0
.20	.99512	.98544	5.8	9.2
.21	.99490	.98477	6.1	9.4
.22	.99467	.98409	6.3	9.6
.23	.99444	.98343	6.6	9.8
.24	.99422	.98276	6.9	10.0
.25	.99400	.98210	7.1	10.2
.26	.99378	.98145	7.4	10.4
.27	.99356	.98080	7.6	10.5
.28	.99334	.98015	7.9	10.7
.29	.99312	.97951	8.1	10.9
.30	.99291	.97887	8.4	11.1
.31	.99269	.97824	8.6	11.2
.32	.99248	.97761	8.9	11.4
.33	.99227	.97698	9.1	11.5
.34	.99206	.97636	9.4	11.7
.35	.99185	.97574	9.6	11.8
.36	.99164	.97512	9.9	12.0
.37	.99143	.97451	10.1	12.1
.38	.99122	.97390	10.3	12.2
.39	.99102	.97330	10.6	12.3
.40	.99081	.97270	10.8	12.5
.41	.99061	.97210	11.0	12.6

.12	.99041	.97151	11.3	12.7
.13	.99021	.97091	11.5	12.8
.14	.99001	.97033	11.7	12.9
.15	.98981	.96974	12.0	13.0
.16	.98961	.96916	12.2	13.1
.17	.98942	.96858	12.4	13.2
.18	.98922	.96801	12.6	13.3
.19	.98902	.96743	12.9	13.4
.50	.98883	.96686	13.1	13.5
.51	.98864	.96630	13.3	13.6
.52	.98844	.96573	13.5	13.7
.53	.98825	.96517	13.7	13.7
.54	.98806	.96461	14.0	13.8
.55	.98787	.96406	14.2	13.9
.56	.98768	.96350	14.4	13.9
.57	.98749	.96295	14.6	14.0
.58	.98731	.96240	14.8	14.0
.59	.98712	.96186	15.0	14.1
.60	.98693	.96131	15.2	14.1
.61	.98675	.96077	15.5	14.2
.62	.98656	.96023	15.7	14.2
.63	.98638	.95969	15.9	14.3
.64	.98620	.95916	16.1	14.3
.65	.98601	.95862	16.3	14.3
.66	.98583	.95809	16.5	14.4
.67	.98565	.95756	16.7	14.4
.68	.98547	.95703	16.9	14.4
.69	.98529	.95651	17.1	14.4
.70	.98511	.95598	17.3	14.5
.71	.98493	.95546	17.5	14.5
.72	.98475	.95494	17.7	14.5
.73	.98457	.95442	17.9	14.5
.74	.98439	.95390	18.1	14.5
.75	.98421	.95338	18.3	14.5
.76	.98403	.95286	18.5	14.5
.77	.98386	.95235	18.7	14.5
.78	.98368	.95183	18.9	14.5
.79	.98350	.95132	19.1	14.5
.80	.98333	.95081	19.3	14.4
.81	.98315	.95029	19.5	14.4
.82	.98297	.94978	19.7	14.4
.83	.98280	.94927	19.8	14.4
.84	.98262	.94876	20.0	14.3
.85	.98244	.94825	20.2	14.3
.86	.98227	.94775	20.4	14.3
.87	.98209	.94724	20.6	14.2
.88	.98192	.94673	20.8	14.2
.89	.98174	.94622	21.0	14.1
.90	.98157	.94571	21.2	14.1
.91	.98139	.94521	21.3	14.0
.92	.98122	.94470	21.5	14.0
.93	.98104	.94419	21.7	13.9
.94	.98086	.94368	21.9	13.9
.95	.98069	.94318	22.1	13.8

.96	.98051	.94267	22.2	13.8
.97	.98034	.94216	22.4	13.7
.98	.98016	.94165	22.6	13.6
.99	.97998	.94114	22.8	13.5
1.00	.97981	.94063	23.0	13.5
1.01	.97963	.94013	23.1	13.1
1.02	.97945	.93962	23.3	13.3
1.03	.97928	.93911	23.5	13.2
1.04	.97910	.93859	23.7	13.1
1.05	.97892	.93808	23.8	13.0
1.06	.97874	.93757	24.0	12.9
1.07	.97856	.93706	24.2	12.8
1.08	.97838	.93654	24.3	12.7
1.09	.97821	.93603	24.5	12.6
1.10	.97803	.93552	24.7	12.5
1.11	.97785	.93500	24.9	12.4
1.12	.97767	.93448	25.0	12.3
1.13	.97749	.93397	25.2	12.2
1.14	.97730	.93345	25.4	12.1
1.15	.97712	.93293	25.5	12.0
1.16	.97694	.93241	25.7	11.8
1.17	.97676	.93189	25.8	11.7
1.18	.97658	.93136	26.0	11.6
1.19	.97639	.93084	26.2	11.5
1.20	.97621	.93032	26.3	11.3
1.21	.97603	.92979	26.5	11.2
1.22	.97584	.92926	26.7	11.1
1.23	.97566	.92874	26.8	10.9
1.24	.97547	.92821	27.0	10.8
1.25	.97529	.92768	27.1	10.6
1.26	.97510	.92714	27.3	10.5
1.27	.97491	.92661	27.4	10.3
1.28	.97473	.92608	27.6	10.2
1.29	.97454	.92554	27.8	10.0
1.30	.97435	.92501	27.9	9.9
1.31	.97416	.92447	28.1	9.7
1.32	.97397	.92393	28.2	9.6
1.33	.97378	.92339	28.4	9.4
1.34	.97359	.92285	28.5	9.3
1.35	.97340	.92231	28.7	9.1
1.36	.97321	.92177	28.8	8.9
1.37	.97302	.92123	29.0	8.7
1.38	.97283	.92068	29.1	8.6
1.39	.97263	.92014	29.3	8.4
1.40	.97244	.91958	29.4	8.2
1.41	.97225	.91903	29.6	8.0
1.42	.97205	.91848	29.7	7.8
1.43	.97186	.91793	29.8	7.6
1.44	.97166	.91737	30.0	7.4
1.45	.97147	.91682	30.1	7.2
1.46	.97127	.91626	30.3	7.0
1.47	.97107	.91571	30.4	6.8
1.48	.97088	.91515	30.6	6.6
1.49	.97068	.91459	30.7	6.4

1.50	.97048	.91403	30.8	6.2
1.51	.97028	.91347	31.0	6.0
1.52	.97008	.91290	31.1	5.8
1.53	.96988	.91234	31.2	5.6
1.54	.96968	.91177	31.4	5.4
1.55	.96948	.91121	31.5	5.2
1.56	.96928	.91064	31.6	5.0
1.57	.96908	.91007	31.8	4.8
1.58	.96887	.90950	31.9	4.5
1.59	.96867	.90893	32.0	4.3
1.60	.96847	.90836	32.2	4.1
1.61	.96826	.90778	32.3	3.9
1.62	.96806	.90721	32.4	3.7
1.63	.96785	.90663	32.6	3.4
1.64	.96765	.90607	32.7	3.2
1.65	.96744	.90548	32.8	3.0
1.66	.96724	.90490	32.9	2.7
1.67	.96703	.90432	33.1	2.5
1.68	.96682	.90374	33.2	2.3
1.69	.96662	.90315	33.3	2.0
1.70	.96641	.90257	33.4	1.8
1.71	.96620	.90199	33.6	1.5
1.72	.96599	.90140	33.7	1.3
1.73	.96578	.90081	33.8	1.0
1.74	.96557	.90023	33.9	.8
1.75	.96536	.89964	34.1	.5
1.76	.96515	.89905	34.2	.3
1.77	.96494	.89846	34.3	.0
1.78	.96473	.89787	34.4	-.2

TABLE C-8. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 30 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 30.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99981	.99944	.4	4.0
.02	.99963	.99889	.9	4.0
.03	.99944	.99834	1.3	4.0
.04	.99926	.99779	1.8	4.0
.05	.99908	.99724	2.2	4.0
.06	.99890	.99670	2.6	3.9
.07	.99872	.99616	3.0	3.9
.08	.99854	.99562	3.5	3.9
.09	.99836	.99508	3.9	3.9
.10	.99818	.99454	4.3	3.8
.11	.99800	.99402	4.7	3.8
.12	.99783	.99349	5.1	3.8
.13	.99765	.99297	5.5	3.7
.14	.99747	.99244	5.9	3.7
.15	.99730	.99192	6.3	3.7
.16	.99713	.99140	6.6	3.6
.17	.99695	.99089	7.0	3.6
.18	.99678	.99037	7.4	3.5
.19	.99661	.98986	7.8	3.5
.20	.99644	.98935	8.1	3.4
.21	.99627	.98884	8.5	3.3
.22	.99610	.98833	8.9	3.3
.23	.99593	.98783	9.2	3.2
.24	.99576	.98733	9.6	3.1
.25	.99559	.98683	10.0	3.1
.26	.99542	.98633	10.3	3.0
.27	.99525	.98583	10.7	2.9
.28	.99509	.98533	11.0	2.8
.29	.99492	.98484	11.3	2.8
.30	.99475	.98435	11.7	2.7
.31	.99459	.98386	12.0	2.6
.32	.99442	.98337	12.4	2.5
.33	.99426	.98289	12.7	2.4
.34	.99410	.98239	13.0	2.3
.35	.99393	.98191	13.3	2.2
.36	.99377	.98142	13.7	2.1
.37	.99361	.98094	14.0	2.0
.38	.99344	.98046	14.3	1.9
.39	.99328	.97998	14.6	1.8
.40	.99312	.97950	14.9	1.7
.41	.99296	.97902	15.3	1.6

.43	.99264	.97807	15.9	1.4
.44	.99248	.97760	16.2	1.2
.45	.99232	.97713	16.5	1.1
.46	.99216	.97665	16.8	1.0
.47	.99200	.97618	17.1	.9
.48	.99184	.97571	17.4	.8
.49	.99168	.97524	17.7	.6
.50	.99152	.97478	18.0	.5
.51	.99136	.97431	18.2	.4
.52	.99120	.97384	18.5	.2
.53	.99105	.97338	18.8	.1
.54	.99089	.97291	19.1	.1

TABLE C-9. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 50 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 50
Speed (fps): 45.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99978	.99933	.4	4.0
.02	.99956	.99867	.9	4.0
.03	.99933	.99800	1.3	4.0
.04	.99911	.99735	1.8	4.0
.05	.99890	.99669	2.2	4.0
.06	.99868	.99604	2.6	3.9
.07	.99846	.99539	3.0	3.9
.08	.99824	.99474	3.5	3.9
.09	.99803	.99410	3.9	3.9
.10	.99782	.99346	4.3	3.8
.11	.99760	.99283	4.7	3.8
.12	.99739	.99219	5.1	3.8
.13	.99718	.99156	5.5	3.7
.14	.99697	.99093	5.9	3.7
.15	.99676	.99031	6.3	3.7
.16	.99655	.98968	6.7	3.6
.17	.99634	.98906	7.0	3.6
.18	.99613	.98844	7.4	3.5
.19	.99593	.98783	7.8	3.4
.20	.99572	.98721	8.2	3.4
.21	.99551	.98660	8.5	3.3
.22	.99531	.98599	8.9	3.3
.23	.99510	.98539	9.3	3.2
.24	.99490	.98478	9.6	3.1
.25	.99470	.98418	10.0	3.1
.26	.99450	.98358	10.4	3.0
.27	.99429	.98298	10.7	2.9
.28	.99409	.98239	11.1	2.8
.29	.99389	.98179	11.4	2.8
.30	.99369	.98120	11.7	2.7
.31	.99349	.98061	12.1	2.6
.32	.99330	.98002	12.4	2.5
.33	.99310	.97943	12.8	2.4
.34	.99290	.97885	13.1	2.3
.35	.99270	.97826	13.4	2.2
.36	.99250	.97768	13.8	2.1
.37	.99231	.97710	14.1	2.0
.38	.99211	.97652	14.4	1.9
.39	.99192	.97595	14.7	1.8
.40	.99172	.97537	15.0	1.7
.41	.99153	.97480	15.4	1.6

.42	.99133	.97422	15.7	1.5
.43	.99114	.97365	16.0	1.4
.44	.99095	.97308	16.3	1.2
.45	.99075	.97251	16.6	1.1
.46	.99056	.97194	16.9	1.0
.47	.99037	.97138	17.2	.9
.48	.99017	.97081	17.5	.7
.49	.98998	.97025	17.8	.6
.50	.98979	.96968	18.1	.5
.51	.98960	.96912	18.4	.3
.52	.98941	.96857	18.7	.2
.53	.98922	.96800	19.0	.1
.54	.98903	.96744	19.2	.1

TABLE C-10. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 90 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 90.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99970	.99911	.4	4.0
.02	.99941	.99823	.9	4.0
.03	.99912	.99736	1.3	4.0
.04	.99883	.99648	1.8	4.0
.05	.99854	.99561	2.2	4.0
.06	.99825	.99475	2.6	3.9
.07	.99796	.99389	3.0	3.9
.08	.99767	.99303	3.5	3.9
.09	.99739	.99218	3.9	3.9
.10	.99710	.99133	4.3	3.8
.11	.99682	.99049	4.7	3.8
.12	.99654	.98964	5.1	3.8
.13	.99625	.98880	5.5	3.7
.14	.99597	.98797	5.9	3.7
.15	.99569	.98714	6.3	3.7
.16	.99542	.98631	6.7	3.6
.17	.99514	.98548	7.1	3.6
.18	.99486	.98466	7.5	3.5
.19	.99459	.98384	7.9	3.4
.20	.99431	.98303	8.3	3.4
.21	.99404	.98222	8.6	3.3
.22	.99376	.98141	9.0	3.3
.23	.99349	.98060	9.3	3.2
.24	.99322	.97979	9.7	3.1
.25	.99295	.97899	10.1	3.1
.26	.99268	.97819	10.4	3.0
.27	.99241	.97740	10.8	2.9
.28	.99214	.97660	11.2	2.8
.29	.99187	.97581	11.6	2.7
.30	.99160	.97502	11.9	2.7
.31	.99134	.97424	12.3	2.6
.32	.99107	.97345	12.6	2.5
.33	.99081	.97267	12.9	2.4
.34	.99054	.97189	13.2	2.3
.35	.99028	.97111	13.6	2.2
.36	.99001	.97034	13.9	2.1
.37	.98975	.96957	14.2	2.0
.38	.98949	.96879	14.6	1.9
.39	.98923	.96803	14.9	1.8
.40	.98896	.96726	15.2	1.7
.41	.98870	.96649	15.5	1.6

.42	.98844	.96573	15.9	1.5
.43	.98818	.96497	16.2	1.3
.44	.98792	.96421	16.5	1.2
.45	.98766	.96345	16.8	1.1
.46	.98741	.96269	17.1	1.0
.47	.98715	.96194	17.4	.8
.48	.98689	.96118	17.7	.7
.49	.98663	.96043	18.0	.6
.50	.98637	.95968	18.3	.5
.51	.98612	.95893	18.6	.3
.52	.98586	.95818	18.9	.2
.53	.98560	.95743	19.2	.0
.54	.98535	.95669	19.5	-.1

TABLE C-11. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 110 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 110.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99967	.99901	.4	4.0
.02	.99934	.99803	.9	4.0
.03	.99902	.99706	1.3	4.0
.04	.99869	.99608	1.8	4.0
.05	.99837	.99512	2.2	4.0
.06	.99805	.99415	2.6	3.9
.07	.99773	.99319	3.1	3.9
.08	.99741	.99224	3.5	3.9
.09	.99709	.99129	3.9	3.9
.10	.99677	.99034	4.3	3.8
.11	.99645	.98940	4.7	3.8
.12	.99614	.98846	5.1	3.8
.13	.99582	.98753	5.5	3.7
.14	.99551	.98659	5.9	3.7
.15	.99520	.98567	6.3	3.7
.16	.99489	.98474	6.7	3.6
.17	.99458	.98382	7.1	3.6
.18	.99427	.98291	7.5	3.5
.19	.99396	.98199	7.9	3.4
.20	.99365	.98108	8.3	3.4
.21	.99335	.98018	8.6	3.3
.22	.99304	.97927	9.0	3.3
.23	.99274	.97837	9.4	3.2
.24	.99243	.97747	9.7	3.1
.25	.99213	.97658	10.1	3.1
.26	.99183	.97569	10.4	3.0
.27	.99153	.97480	10.8	2.9
.28	.99123	.97391	11.2	2.8
.29	.99093	.97303	11.5	2.7
.30	.99063	.97215	11.9	2.7
.31	.99033	.97127	12.3	2.6
.32	.99003	.97040	12.6	2.5
.33	.98974	.96952	12.9	2.4
.34	.98944	.96865	13.3	2.3
.35	.98914	.96779	13.6	2.2
.36	.98885	.96692	14.0	2.1
.37	.98855	.96606	14.3	2.0
.38	.98826	.96519	14.6	1.9
.39	.98797	.96434	15.0	1.8
.40	.98767	.96348	15.3	1.7
.41	.98738	.96262	15.6	1.6

.42	.98709	.96177	15.9	1.4
.43	.98680	.96092	16.3	1.3
.44	.98651	.96007	16.6	1.2
.45	.98622	.95922	16.9	1.1
.46	.98593	.95838	17.2	1.0
.47	.98564	.95753	17.5	.8
.48	.98535	.95668	17.8	.7
.49	.98506	.95585	18.1	.6
.50	.98477	.95501	18.4	.4
.51	.98449	.95418	18.7	.3
.52	.98420	.95334	19.0	.2
.53	.98391	.95251	19.3	.0
.54	.98362	.95167	19.6	.1

TABLE C-12. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 30 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 30.
Diameter (inches): .1000 Arbient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99975	.99925	.4	4.0
.02	.99950	.99850	.9	4.0
.03	.99925	.99776	1.3	4.0
.04	.99901	.99702	1.8	4.0
.05	.99876	.99629	2.3	4.0
.06	.99852	.99556	2.6	3.9
.07	.99827	.99482	3.0	3.9
.08	.99803	.99410	3.5	3.9
.09	.99779	.99338	3.9	3.9
.10	.99755	.99266	4.3	3.8
.11	.99731	.99194	4.7	3.8
.12	.99707	.99123	5.1	3.8
.13	.99683	.99052	5.5	3.7
.14	.99659	.98981	5.9	3.7
.15	.99636	.98911	6.3	3.7
.16	.99612	.98841	6.7	3.6
.17	.99589	.98771	7.1	3.6
.18	.99565	.98702	7.4	3.5
.19	.99542	.98632	7.8	3.4
.20	.99519	.98563	8.2	3.4
.21	.99496	.98495	8.6	3.3
.22	.99473	.98426	8.9	3.3
.23	.99450	.98358	9.3	3.2
.24	.99427	.98290	9.7	3.1
.25	.99404	.98222	10.0	3.1
.26	.99381	.98155	10.4	3.0
.27	.99358	.98087	10.8	2.9
.28	.99336	.98020	11.1	2.8
.29	.99313	.97953	11.5	2.7
.30	.99291	.97887	11.8	2.7
.31	.99268	.97820	12.1	2.6
.32	.99246	.97754	12.5	2.5
.33	.99223	.97688	12.8	2.4
.34	.99201	.97622	13.2	2.3
.35	.99179	.97556	13.5	2.2
.36	.99156	.97491	13.8	2.1
.37	.99134	.97425	14.2	2.0
.38	.99112	.97360	14.5	1.9
.39	.99090	.97295	14.8	1.8
.40	.99068	.97230	15.1	1.7
.41	.99046	.97166	15.4	1.6

.42	.99024	.97101	15.8	1.5
.43	.99002	.97037	16.1	1.3
.44	.98980	.96972	16.4	1.2
.45	.98959	.96908	16.7	1.1
.46	.98937	.96844	17.0	1.0
.47	.98915	.96780	17.3	.9
.48	.98893	.96717	17.6	.7
.49	.98872	.96653	17.9	.6
.50	98850	.96590	18.2	.5
.51	.98828	.96526	18.5	.3
.52	.98807	.96463	18.8	.2
.53	.98785	.96400	19.1	.1
.54	.98764	.96337	19.4	-.1

TABLE C-13. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 70 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 70.
Diameter (inches): .1000
Speed (fps): 45.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99973	.99919	.4	4.0
.02	.99946	.99839	.9	4.0
.03	.99919	.99758	1.3	4.0
.04	.99893	.99679	1.8	4.0
.05	.99866	.99599	2.2	4.0
.06	.99840	.99520	2.6	3.9
.07	.99814	.99441	3.0	3.9
.08	.99787	.99363	3.5	3.9
.09	.99761	.99286	3.9	3.9
.10	.99735	.99208	4.3	3.8
.11	.99709	.99131	4.7	3.8
.12	.99684	.99054	5.1	3.8
.13	.99658	.98977	5.5	3.7
.14	.99632	.98901	5.9	3.7
.15	.99607	.98825	6.3	3.7
.16	.99581	.98750	6.7	3.6
.17	.99556	.98674	7.1	3.6
.18	.99531	.98599	7.5	3.5
.19	.99506	.98523	7.9	3.4
.20	.99481	.98450	8.3	3.4
.21	.99456	.98377	8.6	3.3
.22	.99431	.98302	9.0	3.3
.23	.99406	.98229	9.4	3.2
.24	.99381	.98157	9.7	3.2
.25	.99357	.98085	10.0	3.1
.26	.99332	.98013	10.4	3.1
.27	.99308	.97942	10.7	3.0
.28	.99283	.97870	11.1	2.9
.29	.99259	.97799	11.4	2.9
.30	.99234	.97728	11.8	2.8
.31	.99210	.97658	12.1	2.8
.32	.99186	.97587	12.4	2.7
.33	.99162	.97518	12.8	2.7
.34	.99138	.97448	13.1	2.6
.35	.99114	.97379	13.5	2.6
.36	.99090	.97309	13.8	2.5
.37	.99066	.97240	14.1	2.5
.38	.99042	.97171	14.5	2.4
.39	.99018	.97103	14.8	2.3
.40	.98994	.97034	15.1	2.3
.41	.98971	.96967	15.4	2.2

.42	.98947	.96874	15.8	1.5
.43	.98923	.96804	16.1	1.3
.44	.98900	.96735	16.4	1.2
.45	.98876	.96666	16.7	1.1
.46	.98853	.96597	17.0	1.0
.47	.98829	.96528	17.3	.9
.48	.98806	.96460	17.6	.7
.49	.98782	.96391	17.9	.6
.50	.98759	.96323	18.2	.5
.51	.98736	.96254	18.5	.3
.52	.98712	.96186	18.8	.2
.53	.98689	.96118	19.1	.1
.54	.98666	.96050	19.4	-.1

TABLE C-14. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 90 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 90.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.9	4.0
.01	.99972	.99916	.4	4.0
.02	.99944	.99832	.9	4.0
.03	.99916	.99748	1.3	4.0
.04	.99888	.99665	1.8	4.0
.05	.99861	.99583	2.2	4.0
.06	.99833	.99501	2.6	3.9
.07	.99806	.99419	3.0	3.9
.08	.99779	.99337	3.5	3.9
.09	.99751	.99256	3.9	3.9
.10	.99724	.99175	4.3	3.8
.11	.99697	.99095	4.7	3.8
.12	.99671	.99015	5.1	3.8
.13	.99644	.98935	5.5	3.7
.14	.99617	.98856	5.9	3.7
.15	.99591	.98777	6.3	3.7
.16	.99564	.98698	6.7	3.6
.17	.99538	.98620	7.1	3.6
.18	.99512	.98542	7.4	3.5
.19	.99485	.98464	7.8	3.4
.20	.99459	.98387	8.2	3.4
.21	.99433	.98310	8.6	3.3
.22	.99407	.98233	8.9	3.3
.23	.99382	.98156	9.3	3.2
.24	.99356	.98080	9.7	3.1
.25	.99330	.98004	10.0	3.1
.26	.99304	.97928	10.4	3.0
.27	.99279	.97852	10.8	2.9
.28	.99253	.97777	11.1	2.8
.29	.99228	.97702	11.5	2.7
.30	.99203	.97627	11.8	2.7
.31	.99177	.97553	12.1	2.6
.32	.99152	.97478	12.5	2.5
.33	.99127	.97404	12.8	2.4
.34	.99102	.97330	13.2	2.3
.35	.99077	.97257	13.5	2.2
.36	.99052	.97183	13.8	2.1
.37	.99027	.97110	14.2	2.0
.38	.99002	.97037	14.5	1.9
.39	.98977	.96964	14.8	1.8
.40	.98953	.96891	15.1	1.7
.41	.98928	.96818	15.4	1.6

.42	.98903	.96746	15.8	1.5
.43	.98879	.96674	16.1	1.3
.44	.98854	.96602	16.4	1.2
.45	.98830	.96530	16.7	1.1
.46	.98805	.96458	17.0	1.0
.47	.98781	.96387	17.3	.9
.48	.98756	.96315	17.6	.7
.49	.98732	.96244	17.9	.6
.50	.98708	.96173	18.2	.5
.51	.98683	.96102	18.5	.3
.52	.98659	.96031	18.8	.2
.53	.98635	.95960	19.1	.1
.54	.98611	.95889	19.4	-.1

TABLE C-15. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 110 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 45 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 110.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 45.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99971	.99912	.4	4.0
.02	.99942	.99825	.9	4.0
.03	.99912	.99738	1.3	4.0
.04	.99884	.99651	1.8	4.0
.05	.99855	.99565	2.2	4.0
.06	.99826	.99479	2.6	3.9
.07	.99798	.99394	3.0	3.9
.08	.99769	.99309	3.5	3.9
.09	.99741	.99224	3.9	3.9
.10	.99713	.99140	4.3	3.8
.11	.99684	.99056	4.7	3.8
.12	.99656	.98973	5.1	3.8
.13	.99629	.98890	5.5	3.7
.14	.99601	.98807	5.9	3.7
.15	.99573	.98725	6.3	3.7
.16	.99546	.98643	6.7	3.6
.17	.99518	.98561	7.1	3.6
.18	.99491	.98480	7.1	3.5
.19	.99463	.98399	7.8	3.4
.20	.99436	.98318	8.2	3.4
.21	.99409	.98237	8.6	3.3
.22	.99382	.98157	8.9	3.3
.23	.99355	.98077	9.3	3.2
.24	.99328	.97998	9.7	3.1
.25	.99301	.97919	10.0	3.1
.26	.99275	.97840	10.4	3.0
.27	.99248	.97761	10.8	2.9
.28	.99221	.97682	11.1	2.8
.29	.99195	.97601	11.5	2.7
.30	.99168	.97526	11.8	2.7
.31	.99142	.97448	12.1	2.6
.32	.99116	.97371	12.5	2.5
.33	.99090	.97294	12.8	2.4
.34	.99063	.97217	13.2	2.3
.35	.99037	.97140	13.5	2.3
.36	.99011	.97063	13.8	2.1
.37	.98985	.96987	14.2	2.0
.38	.98959	.96910	14.5	1.9
.39	.98933	.96834	14.8	1.8
.40	.98908	.96759	15.1	1.7
.41	.98882	.96683	15.4	1.6

.42	.98856	.96608	15.8	1.5
.43	.98830	.96532	16.1	1.3
.44	.98805	.96457	16.4	1.2
.45	.98779	.96382	16.7	1.1
.46	.98754	.96308	17.0	1.0
.47	.98728	.96233	17.3	.9
.48	.98703	.96159	17.6	.7
.49	.98677	.96084	17.9	.6
.50	.98652	.96010	18.2	.5
.51	.98627	.95936	18.5	.3
.52	.98601	.95862	18.8	.2
.53	.98576	.95789	19.1	.1
.54	.98551	.95715	19.4	-.1

TABLE C-16. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 25 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 25.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99980	.99941	.2	4.0
.02	.99961	.99882	.5	4.0
.03	.99941	.99823	.7	4.0
.04	.99921	.99765	1.0	4.0
.05	.99902	.99706	1.2	4.0
.06	.99882	.99648	1.5	3.9
.07	.99863	.99589	1.7	3.9
.08	.99844	.99531	2.0	3.9
.09	.99824	.99473	2.2	3.9
.10	.99805	.99416	2.4	3.8
.11	.99785	.99358	2.7	3.8
.12	.99766	.99300	2.9	3.8
.13	.99747	.99243	3.1	3.7
.14	.99728	.99185	3.4	3.7
.15	.99708	.99128	3.6	3.6
.16	.99689	.99071	3.8	3.6
.17	.99670	.99014	4.1	3.5
.18	.99651	.98957	4.3	3.5
.19	.99632	.98899	4.5	3.4
.20	.99613	.98843	4.7	3.4
.21	.99594	.98786	5.0	3.3
.22	.99574	.98729	5.2	3.2
.23	.99555	.98672	5.4	3.2
.24	.99536	.98615	5.6	3.1
.25	.99517	.98559	5.9	3.0
.26	.99498	.98502	6.1	3.0
.27	.99479	.98445	6.3	2.9
.28	.99460	.98389	6.5	2.8
.29	.99441	.98332	6.7	2.7
.30	.99422	.98275	6.9	2.6
.31	.99403	.98219	7.1	2.5
.32	.99384	.98162	7.4	2.4
.33	.99364	.98106	7.6	2.3
.34	.99345	.98049	7.8	2.2
.35	.99326	.97992	8.0	2.1
.36	.99307	.97936	8.2	2.0
.37	.99288	.97879	8.4	1.9
.38	.99269	.97823	8.6	1.8
.39	.99250	.97766	8.8	1.7
.40	.99231	.97709	9.0	1.6
.41	.99211	.97653	9.2	1.5

.42	.99192	.97596	9.4	1.4
.43	.99173	.97539	9.6	1.2
.44	.99154	.97482	9.8	1.1
.45	.99134	.97426	10.0	1.0
.46	.99115	.97369	10.2	.8
.47	.99096	.97312	10.4	.7
.48	.99076	.97255	10.6	.6
.49	.99057	.97198	10.8	.4
.50	.99038	.97141	11.0	.3
.51	.99018	.97084	11.2	.2
.52	.98999	.97026	11.4	.0
.53	.98979	.96969	11.6	-.1

TABLE C-17. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 35 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 35.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99977	.99931	.3	4.0
.02	.99954	.99862	.7	4.0
.03	.99931	.99793	1.0	4.0
.04	.99908	.99725	1.4	4.0
.05	.99885	.99657	1.7	4.0
.06	.99863	.99589	2.1	3.9
.07	.99840	.99521	2.4	3.9
.08	.99818	.99454	2.7	3.9
.09	.99795	.99387	3.0	3.9
.10	.99773	.99320	3.4	3.8
.11	.99750	.99253	3.7	3.8
.12	.99728	.99187	4.0	3.8
.13	.99706	.99120	4.3	3.7
.14	.99684	.99054	4.7	3.7
.15	.99662	.98988	5.0	3.6
.16	.99640	.98923	5.3	3.6
.17	.99618	.98857	5.6	3.6
.18	.99596	.98792	5.9	3.5
.19	.99574	.98727	6.2	3.4
.20	.99552	.98662	6.5	3.4
.21	.99530	.98597	6.8	3.3
.22	.99508	.98532	7.1	3.3
.23	.99487	.98468	7.4	3.2
.24	.99465	.98403	7.7	3.1
.25	.99443	.98339	8.0	3.0
.26	.99422	.98275	8.3	3.0
.27	.99400	.98211	8.6	2.9
.28	.99379	.98148	8.9	2.8
.29	.99357	.98084	9.2	2.7
.30	.99336	.98020	9.5	2.6
.31	.99314	.97957	9.7	2.5
.32	.99293	.97894	10.0	2.5
.33	.99272	.97831	10.3	2.4
.34	.99250	.97768	10.6	2.3
.35	.99229	.97705	10.8	2.2
.36	.99208	.97642	11.1	2.1
.37	.99186	.97579	11.4	2.0
.38	.99165	.97517	11.6	1.9
.39	.99144	.97454	11.9	1.8
.40	.99123	.97392	12.2	1.7
.41	.99102	.97329	12.4	1.5

.12	.99081	.97267	12.7	1.4
.13	.99059	.97205	13.0	1.3
.14	.99038	.97142	13.2	1.2
.15	.99017	.97080	13.5	1.0
.16	.98995	.97018	13.7	.9
.17	.98974	.96956	14.0	.8
.18	.98951	.96894	14.2	.7
.19	.98933	.96832	14.5	.5
.50	.98912	.96771	14.7	.4
.51	.98891	.96709	15.0	.2
.52	.98870	.96647	15.2	.1
.53	.98849	.96585	15.5	.0

TABLE C-18. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 55 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 55.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70.
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99971	.99914	.5	4.0
.02	.99943	.99829	1.1	4.0
.03	.99915	.99745	1.6	4.0
.04	.99887	.99661	2.1	4.0
.05	.99859	.99577	2.7	4.0
.06	.99831	.99494	3.2	3.9
.07	.99803	.99411	3.7	3.9
.08	.99776	.99329	4.2	3.9
.09	.99748	.99247	4.7	3.9
.10	.99721	.99166	5.2	3.8
.11	.99694	.99086	5.7	3.8
.12	.99667	.99005	6.2	3.8
.13	.99640	.98925	6.6	3.7
.14	.99614	.98845	7.1	3.7
.15	.99587	.98766	7.6	3.7
.16	.99560	.98687	8.1	3.6
.17	.99534	.98609	8.5	3.6
.18	.99508	.98531	9.0	3.5
.19	.99482	.98453	9.4	3.5
.20	.99456	.98376	9.8	3.4
.21	.99430	.98299	10.3	3.3
.22	.99404	.98223	10.7	3.3
.23	.99378	.98146	11.1	3.2
.24	.99353	.98071	11.6	3.1
.25	.99327	.97995	12.0	3.1
.26	.99302	.97920	12.4	3.0
.27	.99276	.97845	12.8	2.9
.28	.99251	.97770	13.2	2.8
.29	.99226	.97696	13.6	2.7
.30	.99201	.97622	14.1	2.7
.31	.99176	.97549	14.5	2.6
.32	.99151	.97476	14.9	2.5
.33	.99126	.97403	15.3	2.4
.34	.99102	.97331	15.6	2.3
.35	.99077	.97259	16.0	2.2
.36	.99052	.97188	16.4	2.1
.37	.99028	.97117	16.8	2.0
.38	.99004	.97046	17.2	1.9
.39	.98979	.96976	17.5	1.8
.40	.98955	.96906	17.9	1.7
.41	.98931	.96837	18.3	1.6

.42	.98907	.96756	18.6	1.5
.43	.98883	.96685	19.0	.
.44	.98859	.96615	19.3	1.3
.45	.98835	.96544	19.7	1.2
.46	.98811	.96474	20.0	1.0
.47	.98787	.96405	20.4	.9
.48	.98763	.96335	20.7	.8
.49	.98739	.96266	21.1	.7
.50	.98710	.96197	21.4	.5
.51	.98692	.96128	21.8	.4
.52	.98669	.96059	22.1	.3
.53	.98645	.95990	22.4	.1
.54	.98622	.95922	22.8	.0

TABLE C-19. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 65 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000
Speed (fps): 65.0
Nozzle height above ground (ft): 4.0
Ambient Temperature (F): 70
Angle (deg): 0.
Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	0	4.0
.01	.99969	.99907	.6	4.0
.02	.99938	.99815	1.3	4.0
.03	.99908	.99724	1.9	4.0
.04	.99878	.99633	2.5	4.0
.05	.99847	.99543	3.1	4.0
.06	.99817	.99453	3.7	3.9
.07	.99788	.99364	4.3	3.9
.08	.99758	.99276	4.9	3.9
.09	.99729	.99188	5.5	3.9
.10	.99699	.99101	6.1	3.8
.11	.99670	.99015	6.7	3.8
.12	.99642	.98928	7.3	3.8
.13	.99613	.98843	7.7	3.7
.14	.99584	.98758	8.3	3.7
.15	.99556	.98673	8.8	3.7
.16	.99528	.98589	9.4	3.6
.17	.99499	.98506	9.9	3.6
.18	.99471	.98423	10.4	3.5
.19	.99444	.98340	10.9	3.5
.20	.99416	.98258	11.4	3.4
.21	.99388	.98176	11.9	3.3
.22	.99361	.98095	12.4	3.3
.23	.99334	.98014	12.9	3.2
.24	.99306	.97933	13.4	3.2
.25	.99279	.97853	13.9	3.1
.26	.99252	.97774	14.3	3.0
.27	.99226	.97695	14.8	2.9
.28	.99199	.97616	15.3	2.9
.29	.99172	.97538	15.7	2.8
.30	.99146	.97460	16.2	2.7
.31	.99120	.97382	16.6	2.6
.32	.99093	.97305	17.1	2.5
.33	.99067	.97228	17.5	2.4
.34	.99041	.97151	18.0	2.3
.35	.99015	.97075	18.4	2.3
.36	.98989	.96999	18.8	2.2
.37	.98964	.96923	19.2	2.1
.38	.98938	.96848	19.7	2.0
.39	.98913	.96773	20.1	1.9
.40	.98887	.96698	20.5	1.9
.41	.98862	.96624	20.9	1.8

[illegible]	.98836	.96549	21.3	1.5
.42	.98811	.96476	21.7	1.4
.41	.98786	.96402	22.1	1.3
.40	.98761	.96329	22.5	1.2
.39	.98736	.96256	22.9	1.1
.37	.98711	.96183	23.3	1.0
.36	.98686	.96110	23.7	.9
[illegible]	.98662	.96038	24.0	.7
.56	.98637	.95966	24.4	.6
.55	.98612	.95894	24.8	.5
.54	.98588	.95823	25.2	.3
.53	.98563	.95751	25.5	.2
.51	.98539	.95680	25.9	.1
[illegible]	.98515	.95609	26.2	.1

TABLE C-20. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 75 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70
Speed (fps): 75.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99967	.99901	.7	4.0
.02	.99934	.99802	1.5	4.0
.03	.99901	.99705	2.2	4.0
.04	.99869	.99608	2.9	4.0
.05	.99837	.99512	3.6	4.0
.06	.99805	.99416	4.3	3.9
.07	.99773	.99322	5.0	3.9
.08	.99742	.99228	5.6	3.9
.09	.99711	.99134	6.3	3.9
.10	.99680	.99042	6.9	3.8
.11	.99649	.98950	7.6	3.8
.12	.99618	.98859	8.2	3.8
.13	.99588	.98768	8.8	3.7
.14	.99558	.98678	9.5	3.7
.15	.99527	.98589	10.0	3.7
.16	.99498	.98500	10.6	3.6
.17	.99468	.98412	11.2	3.6
.18	.99438	.98325	11.8	3.5
.19	.99409	.98238	12.4	3.5
.20	.99380	.98151	12.9	3.4
.21	.99351	.98065	13.5	3.4
.22	.99322	.97980	14.0	3.3
.23	.99293	.97895	14.6	3.2
.24	.99265	.97811	15.1	3.2
.25	.99236	.97727	15.7	3.1
.26	.99208	.97643	16.2	3.0
.27	.99180	.97560	16.7	3.0
.28	.99152	.97478	17.2	2.9
.29	.99124	.97396	17.7	2.8
.30	.99097	.97314	18.2	2.7
.31	.99069	.97233	18.7	2.6
.32	.99042	.97152	19.2	2.6
.33	.99014	.97072	19.7	2.5
.34	.98987	.96992	20.2	2.4
.35	.98960	.96913	20.7	2.3
.36	.98933	.96833	21.2	2.2
.37	.98906	.96755	21.6	2.1
.38	.98880	.96676	22.0	2.0
.39	.98853	.96598	22.5	1.9
.40	.98826	.96521	23.0	1.8
.41	.98800	.96443	23.4	1.7

[illegible]	.98774	.96366	23.8	1.6
[illegible]	.98748	.96290	24.3	1.5
[illegible]	.98722	.96214	24.7	1.4
[illegible]	.98696	.96138	25.1	1.3
[illegible]	.98670	.96062	25.6	1.1
[illegible]	.98644	.95987	26.0	1.0
[illegible]	.98618	.95912	26.4	.9
[illegible]	.98593	.95837	26.8	.8
[illegible]	.98567	.95762	27.2	.7
[illegible]	.98542	.95688	27.6	.5
[illegible]	.98516	.95614	28.0	.4
[illegible]	.98491	.95541	28.4	.3
[illegible]	.98466	.95468	28.8	.1
[illegible]	.98441	.95394	29.2	.0
[illegible]	.98416	.95322	29.6	.1

TABLE C-21. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 85 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70
Speed (fps): 85.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99965	.99895	.8	4.0
.02	.99930	.99790	1.7	4.0
.03	.99895	.99687	2.5	4.0
.04	.99861	.99584	3.3	4.0
.05	.99827	.99482	4.1	4.0
.06	.99793	.99382	4.8	3.9
.07	.99760	.99282	5.6	3.9
.08	.99727	.99183	6.3	3.9
.09	.99694	.99085	7.1	3.9
.10	.99661	.98987	7.8	3.8
.11	.99629	.98891	8.5	3.8
.12	.99597	.98795	9.2	3.8
.13	.99565	.98700	9.9	3.7
.14	.99533	.98606	10.6	3.7
.15	.99501	.98512	11.2	3.7
.16	.99470	.98419	11.9	3.6
.17	.99439	.98327	12.5	3.6
.18	.99408	.98235	13.2	3.5
.19	.99378	.98144	13.8	3.5
.20	.99347	.98054	14.4	3.4
.21	.99317	.97964	15.0	3.4
.22	.99287	.97875	15.6	3.3
.23	.99257	.97787	16.2	3.3
.24	.99227	.97699	16.8	3.2
.25	.99197	.97611	17.4	3.1
.26	.99168	.97525	18.0	3.0
.27	.99139	.97438	18.5	3.0
.28	.99110	.97353	19.1	2.9
.29	.99081	.97267	19.6	2.8
.30	.99052	.97183	20.2	2.7
.31	.99023	.97099	20.7	2.7
.32	.98995	.97015	21.2	2.6
.33	.98967	.96932	21.8	2.5
.34	.98938	.96849	22.3	2.4
.35	.98910	.96766	22.8	2.3
.36	.98882	.96685	23.3	2.2
.37	.98855	.96603	23.8	2.1
.38	.98827	.96522	24.3	2.0
.39	.98799	.96442	24.8	1.9
.40	.98772	.96361	25.3	1.8
.41	.98745	.96282	25.8	1.7

[illegible]	.98718	.96202	26.2	1.6
[illegible]	.98691	.96123	26.7	1.5
[illegible]	.98664	.96045	27.2	1.4
[illegible]	.98637	.95966	27.6	1.3
[illegible]	.98610	.95889	28.1	1.2
[illegible]	.98584	.95811	28.5	1.1
[illegible]	.98557	.95734	29.0	1.0
[illegible]	.98531	.95657	29.4	.8
[illegible]	.98505	.95581	29.8	.7
[illegible]	.98478	.95504	30.3	.6
[illegible]	.98452	.95429	30.7	.5
[illegible]	.98426	.95353	31.1	.3
[illegible]	.98400	.95278	31.5	.2
[illegible]	.98375	.95203	32.0	.1
[illegible]	.98349	.95128	32.4	-.1

TABLE C-22. TRAJECTORY AND EVAPORATION FOR DROPLET WITH LIQUID TEMPERATURE = 50 °F, DROP DIAMETER = 0.10 INCH, VELOCITY = 95 ft/s, NOZZLE HEIGHT = 4 FEET, AMBIENT TEMPERATURE = 70 °F, AND NOZZLE ANGLE = 0 DEGREES.

Initial conditions
Liquid Temperature (F): 50.
Diameter (inches): .1000 Ambient Temperature (F): 70.
Speed (fps): 95.0 Angle (deg): 0.
Nozzle height above ground (ft): 4.0 Time step (sec): .010

Time (sec)	D/Do	M/Mo	X (ft)	Y (ft)
.00	1.00000	1.00000	.0	4.0
.01	.99963	.99889	.9	4.0
.02	.99926	.99779	1.9	4.0
.03	.99890	.99670	2.8	4.0
.04	.99854	.99562	3.6	4.0
.05	.99818	.99455	4.5	4.0
.06	.99783	.99350	5.4	3.9
.07	.99748	.99245	6.	3.9
.08	.99713	.99141	7.	3.9
.09	.99678	.99038	7.8	3.9
.10	.99644	.98937	8.6	3.8
.11	.99610	.98836	9.4	3.8
.12	.99577	.98736	10.2	3.8
.13	.99543	.98636	10.9	3.7
.14	.99510	.98538	11.6	3.7
.15	.99477	.98441	12.4	3.7
.16	.99445	.98344	13.1	3.6
.17	.99413	.98248	13.8	3.6
.18	.99380	.98153	14.5	3.5
.19	.99349	.98058	15.2	3.5
.20	.99317	.97964	15.8	3.4
.21	.99285	.97871	16.5	3.4
.22	.99254	.97779	17.1	3.3
.23	.99223	.97687	17.8	3.3
.24	.99192	.97596	18.4	3.2
.25	.99162	.97506	19.0	3.1
.26	.99131	.97416	19.7	3.0
.27	.99101	.97327	20.3	3.0
.28	.99071	.97238	20.9	2.9
.29	.99041	.97150	21.5	2.8
.30	.99011	.97063	22.0	2.8
.31	.98982	.96976	22.6	2.7
.32	.98952	.96890	23.2	2.6
.33	.98923	.96804	23.7	2.5
.34	.98894	.96719	24.3	2.4
.35	.98865	.96634	24.8	2.3
.36	.98836	.96549	25.4	2.2
.37	.98808	.96466	25.9	2.2
.38	.98779	.96382	26.4	2.1
.39	.98751	.96300	27.0	2.0
.40	.98723	.96217	27.5	1.9
.41	.98695	.96135	28.0	1.8

[illegible]	.98667	.96054	28.5	1.7
[illegible]	.98639	.95973	29.0	1.6
[illegible]	.98611	.95892	29.5	1.4
[illegible]	.98584	.95812	30.0	1.3
[illegible]	.98557	.95732	30.4	1.2
[illegible]	.98529	.95652	30.9	1.1
[illegible]	.98502	.95573	31.4	1.0
[illegible]	.98475	.95495	31.9	.9
[illegible]	.98448	.95416	32.3	.8
[illegible]	.98421	.95338	32.8	.6
[illegible]	.98395	.95261	33.2	.5
[illegible]	.98368	.95184	33.7	.4
[illegible]	.98342	.95107	34.1	.3
[illegible]	.98315	.95030	34.6	.1
[illegible]	.98289	.94954	35.0	.0
[illegible]	.98263	.94878	35.4	-.1

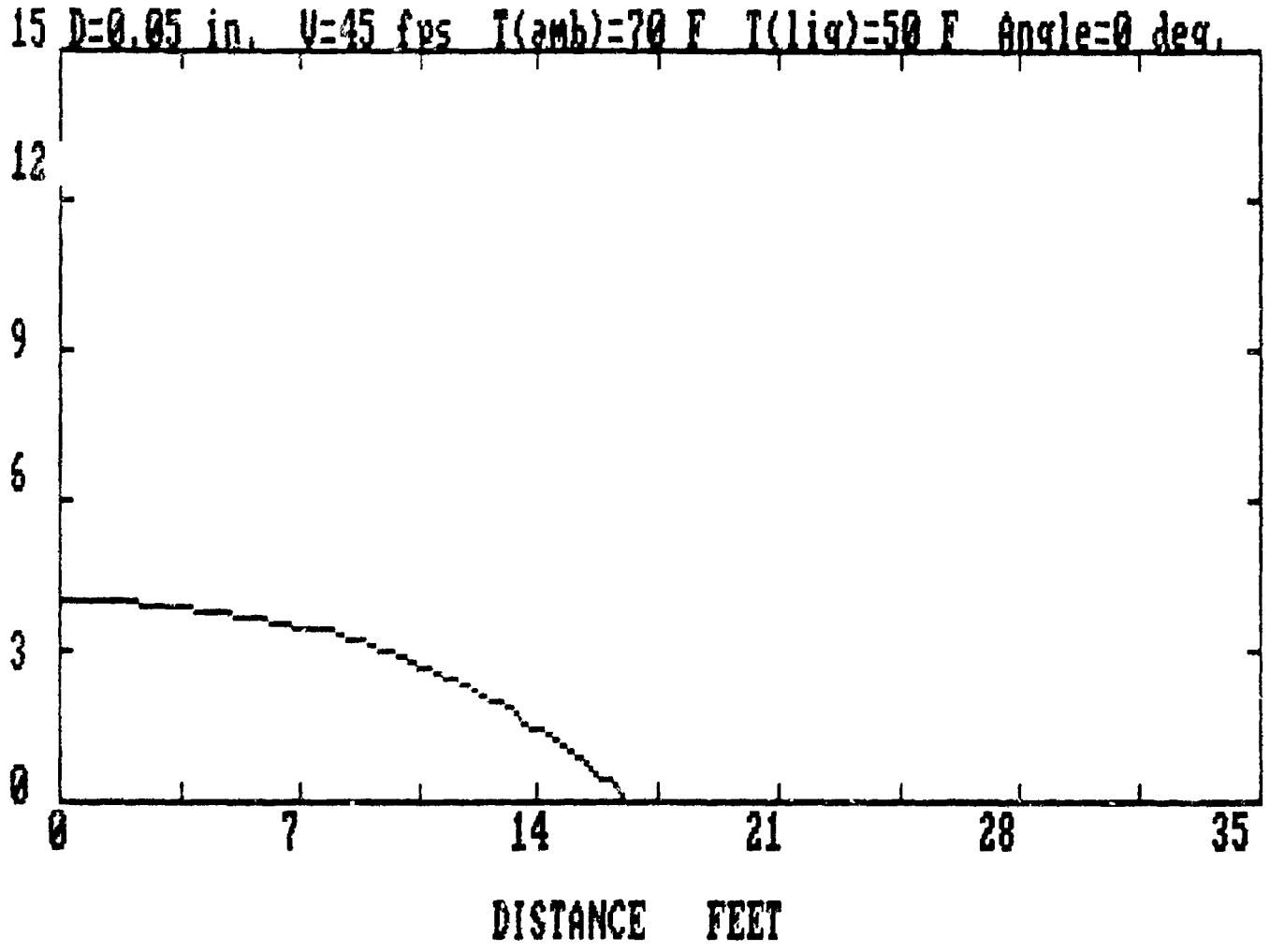

Figure C-1. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.05 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

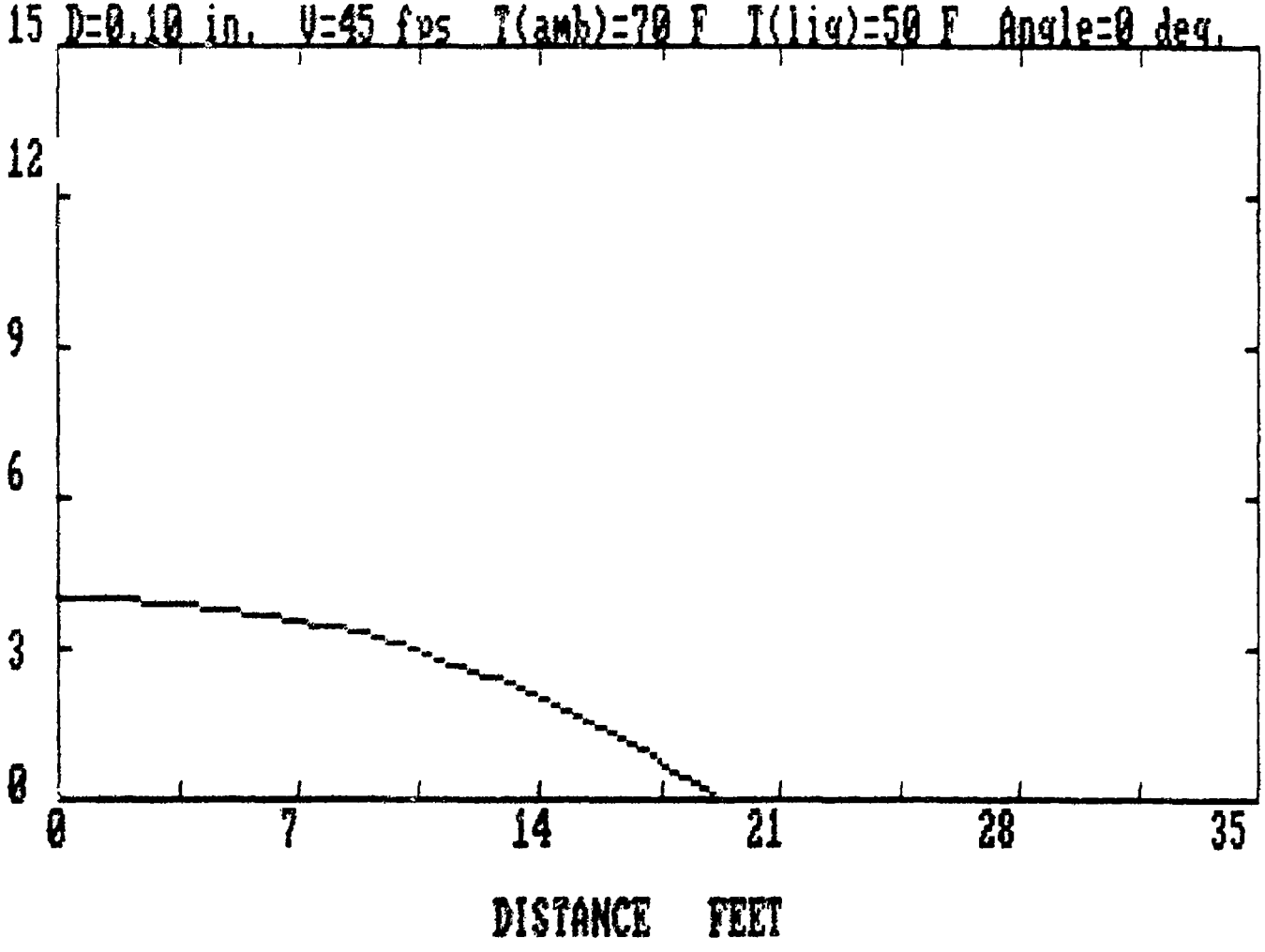

Figure C-2. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

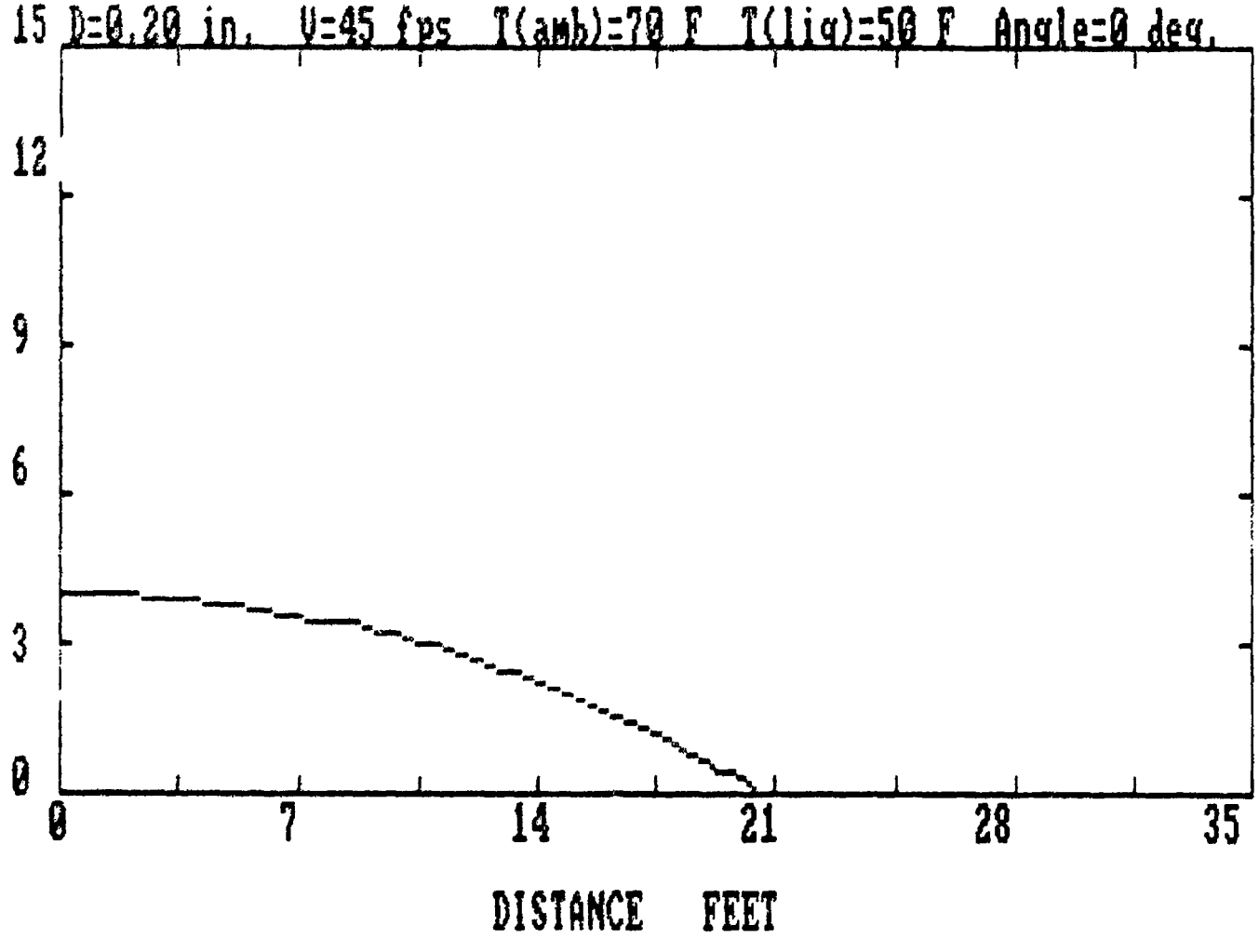

Figure C-3. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.20 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

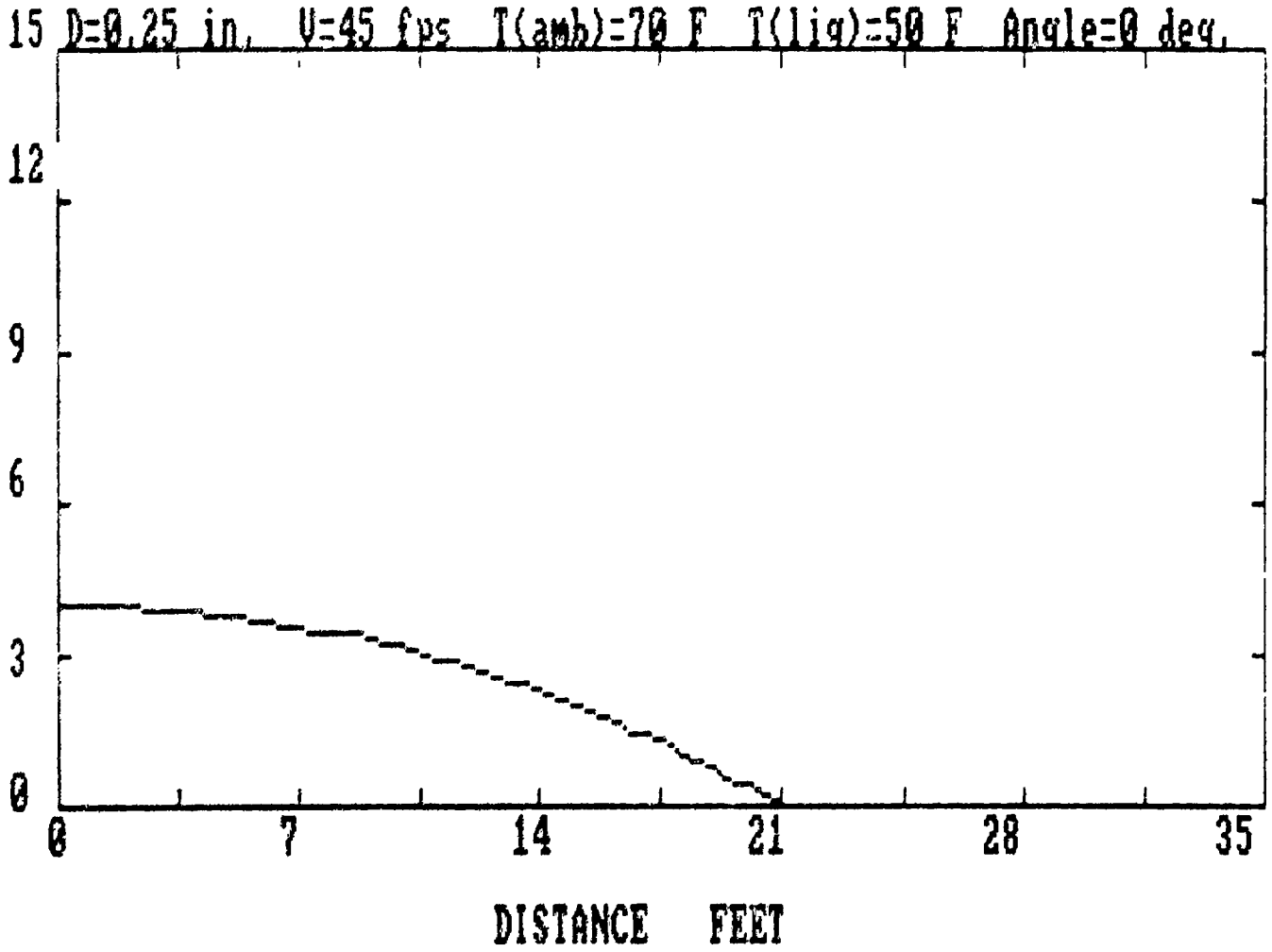

Figure C-4. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.25 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

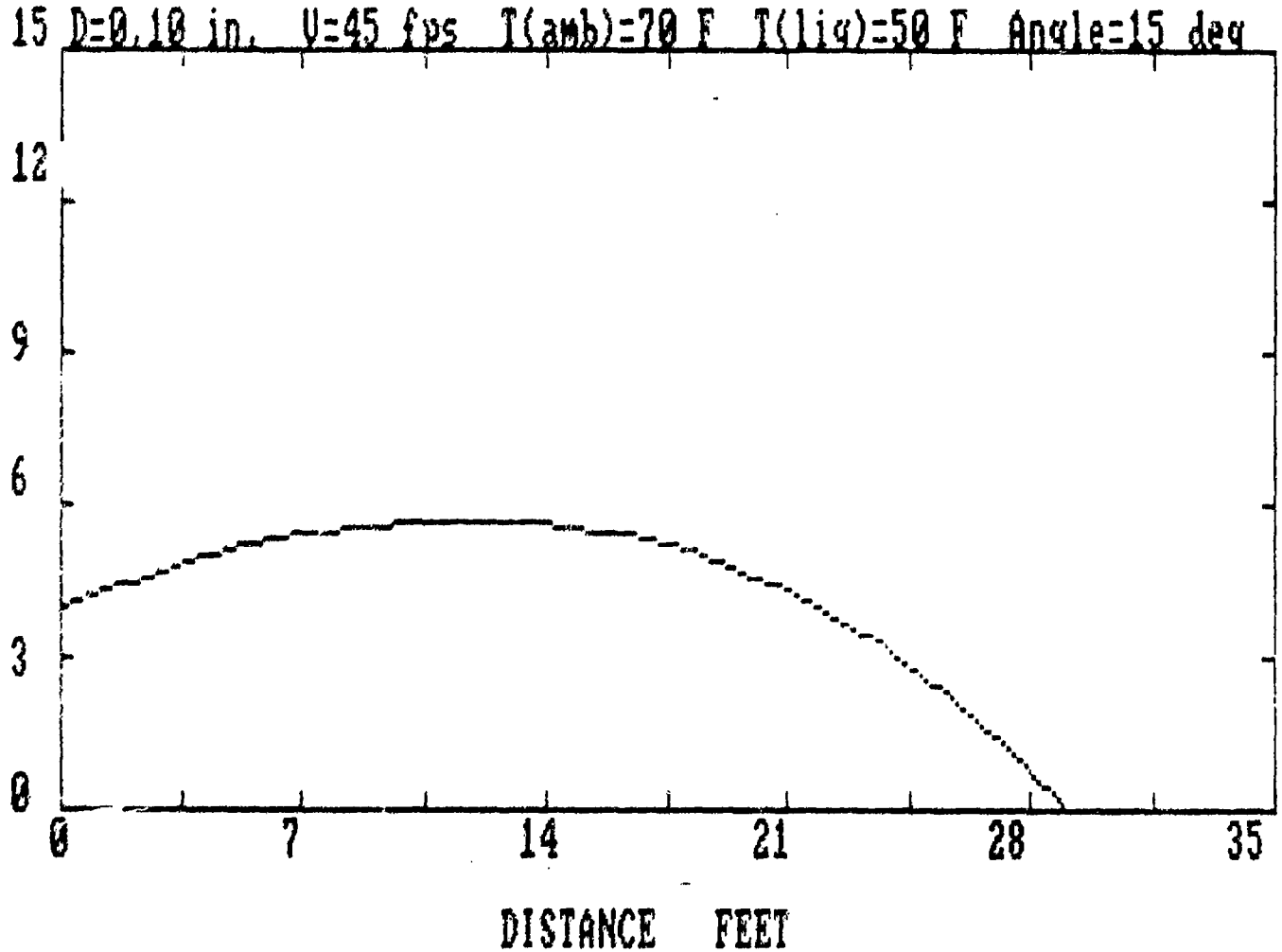

Figure C-5. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 15 Degrees.

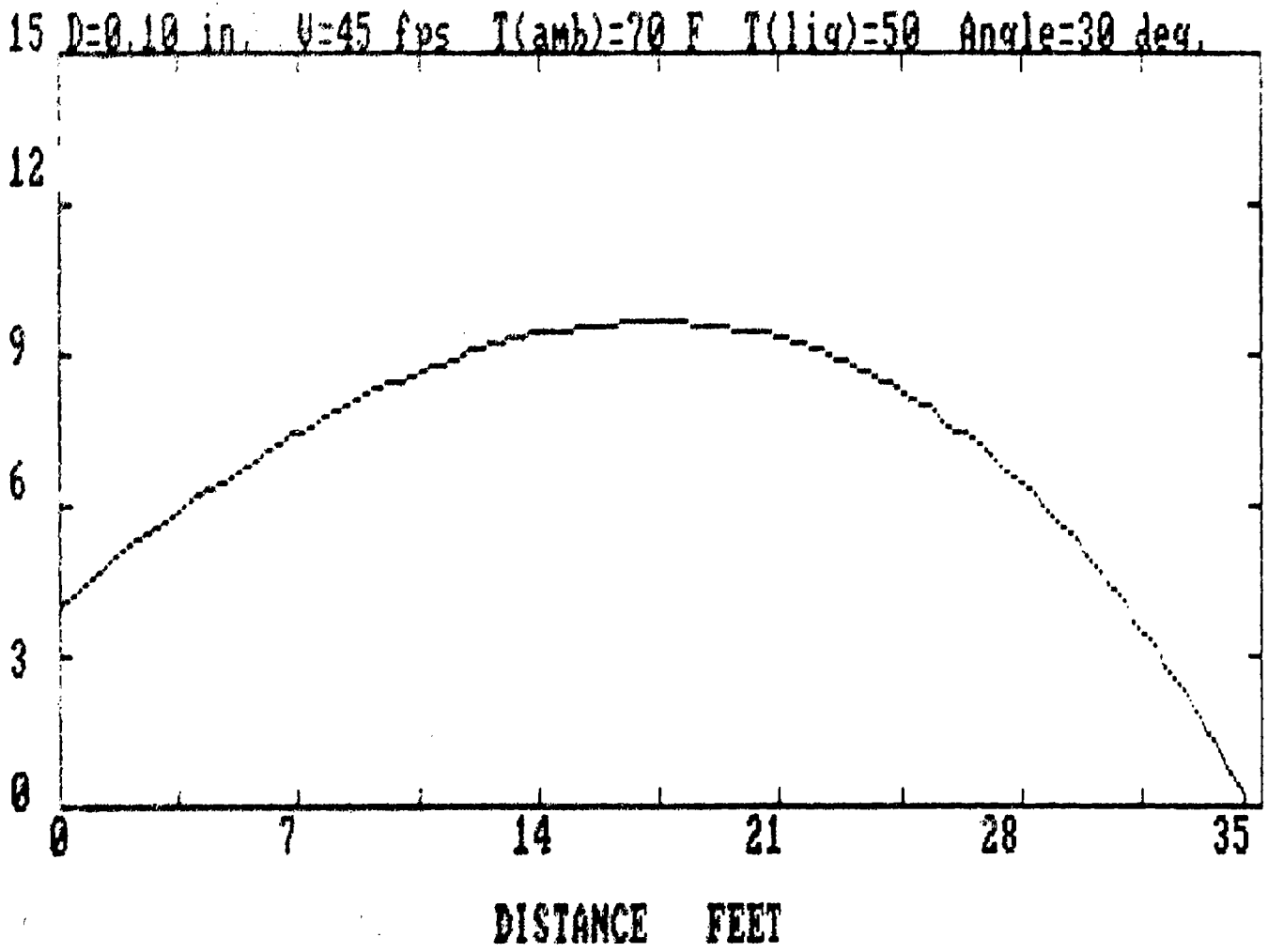

Figure C-6. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 30 Degrees.

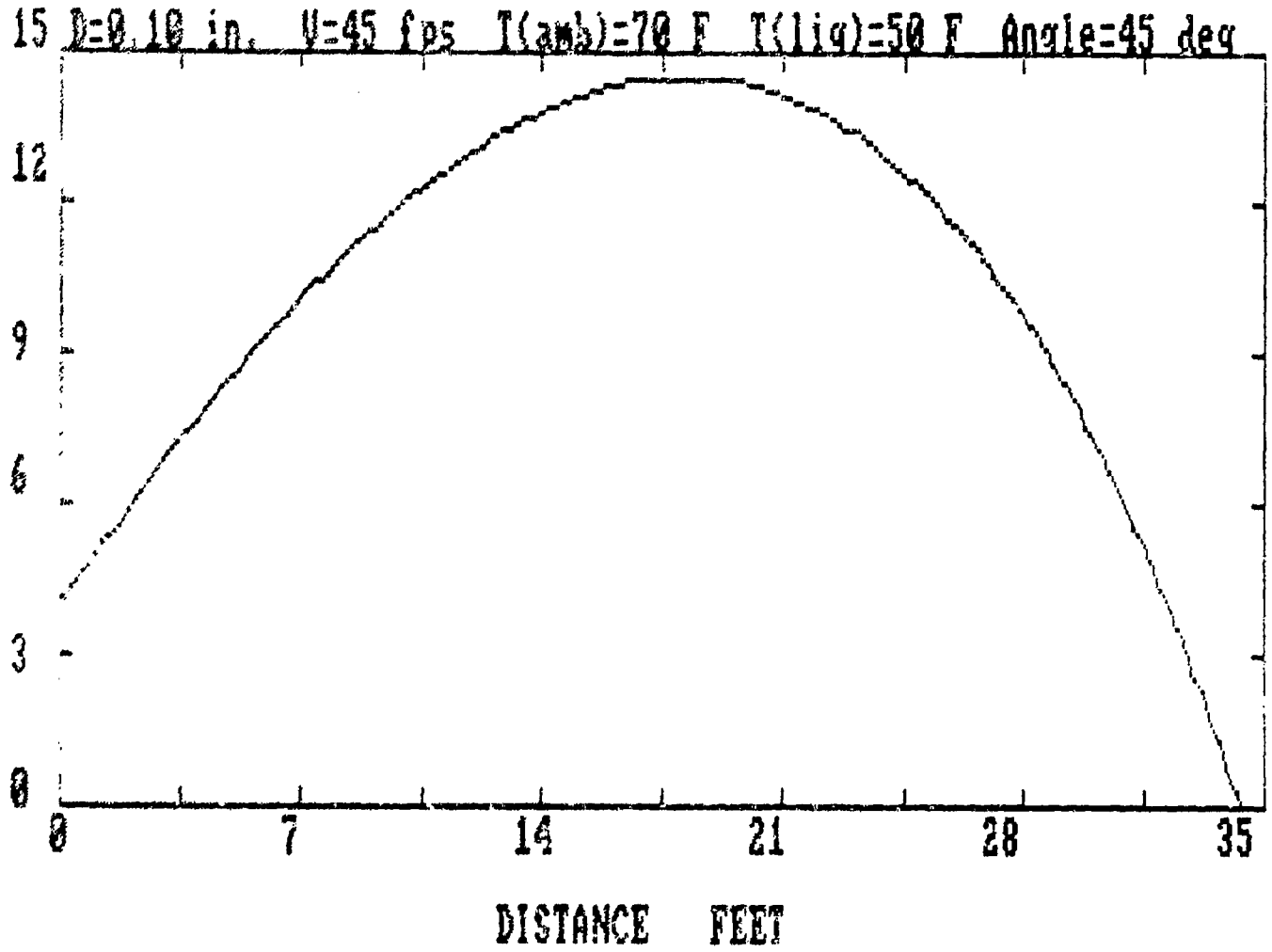

Figure C-7. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 45 Degrees.

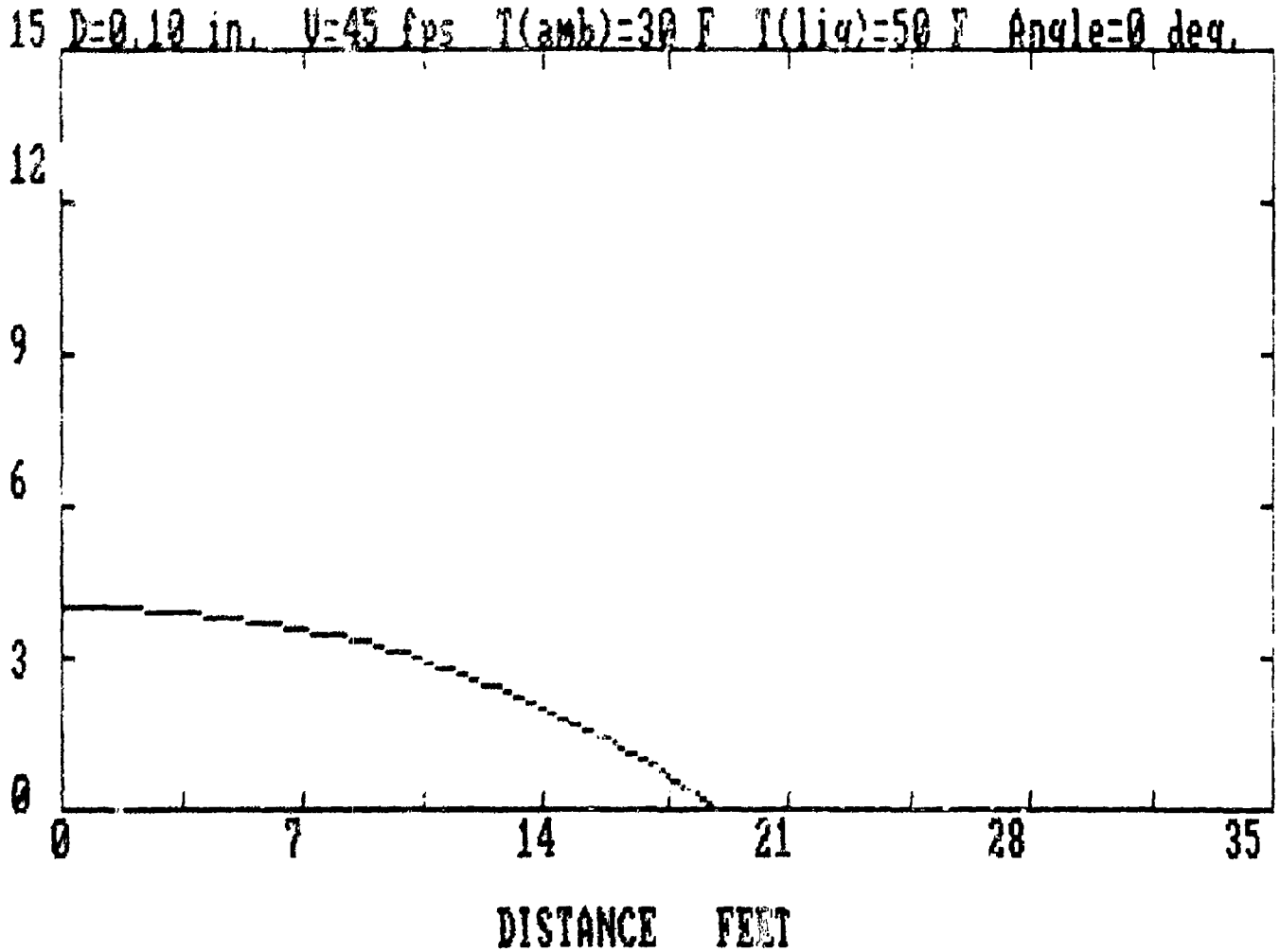

Figure C-8. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 gt/s, Nozzle Height = 4 Feet, Ambient Temperature = 30 °F, and Nozzle Angle = 0 Degrees.

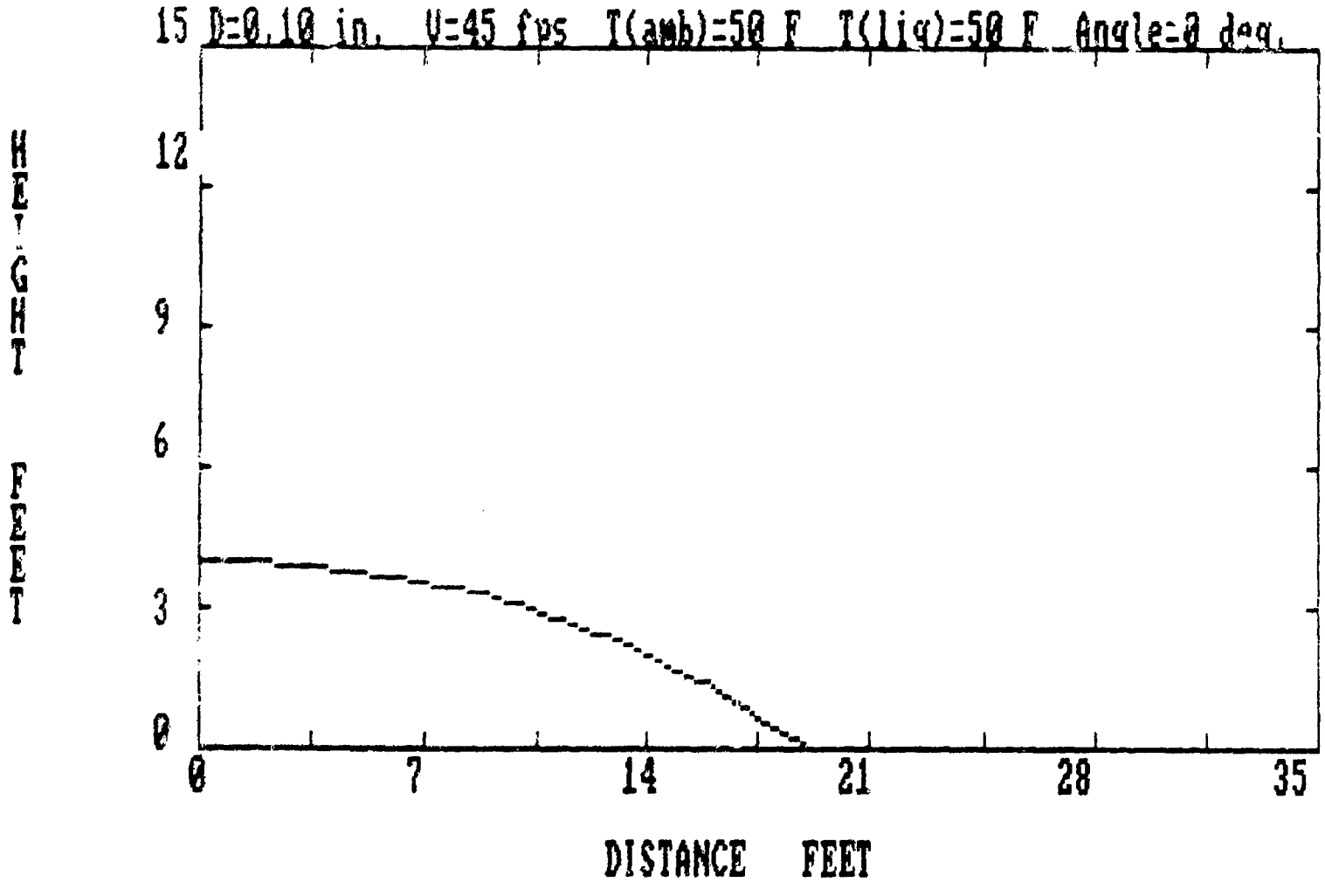

Figure C-9. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 50 °F, and Nozzle Angle = 0 Degrees.

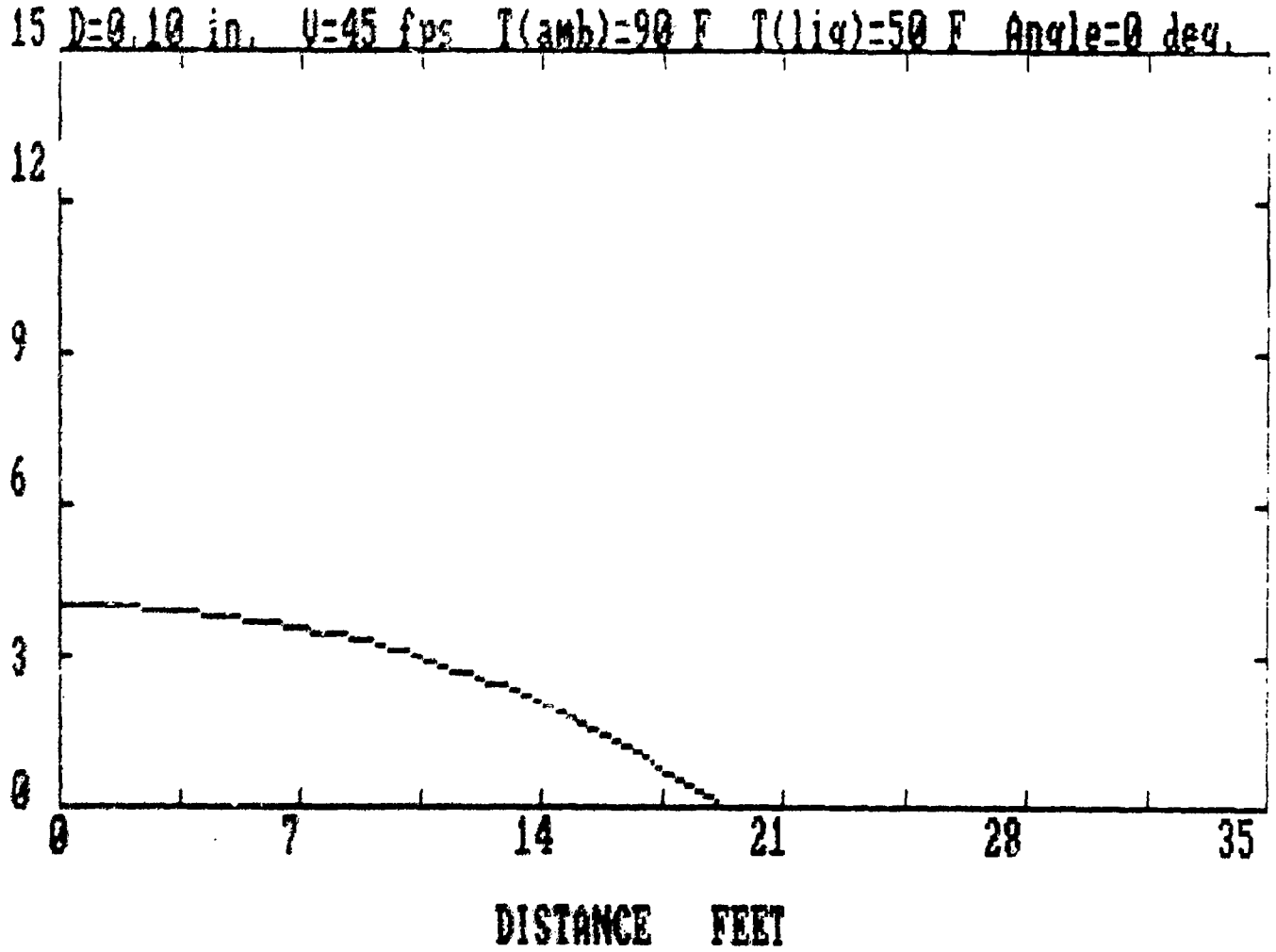

Figure C-10. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 90 °F, and Nozzle Angle = 0 Degrees.

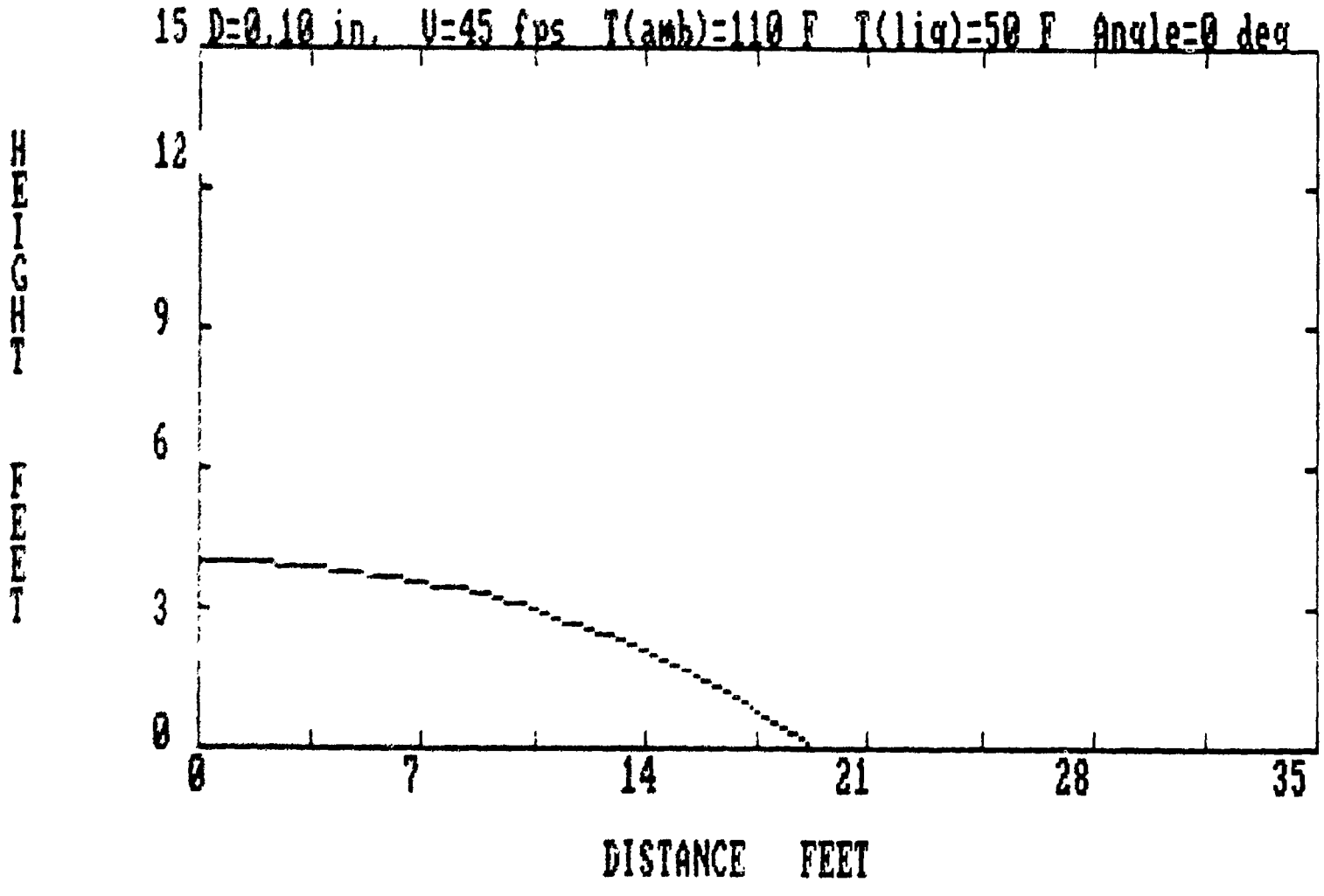

Figure C-11. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 110 °F, and Nozzle Angle = 0 Degrees.

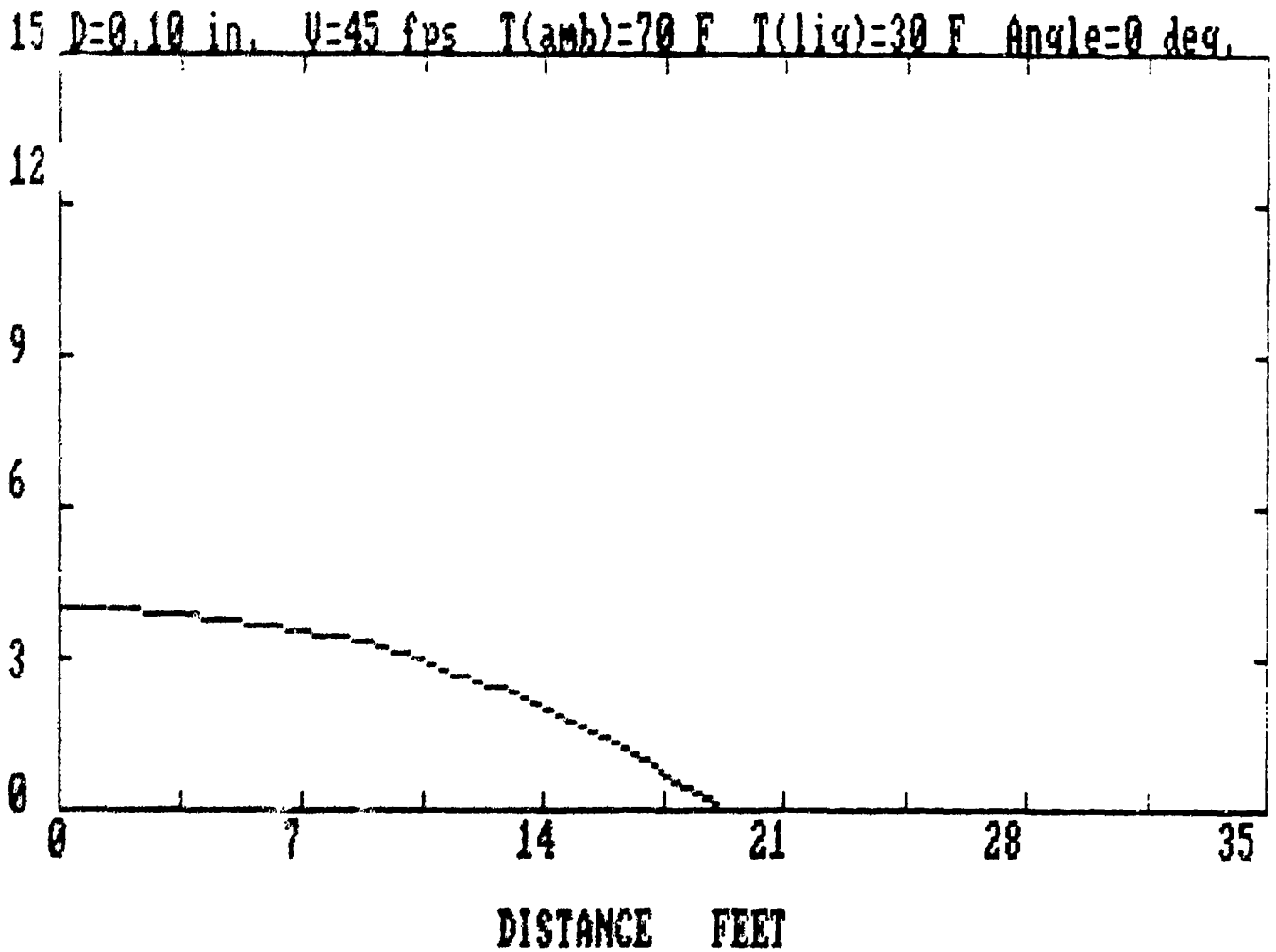

Figure C-12. Calculated Trajectory for Droplet with Liquid Temperature = 30 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

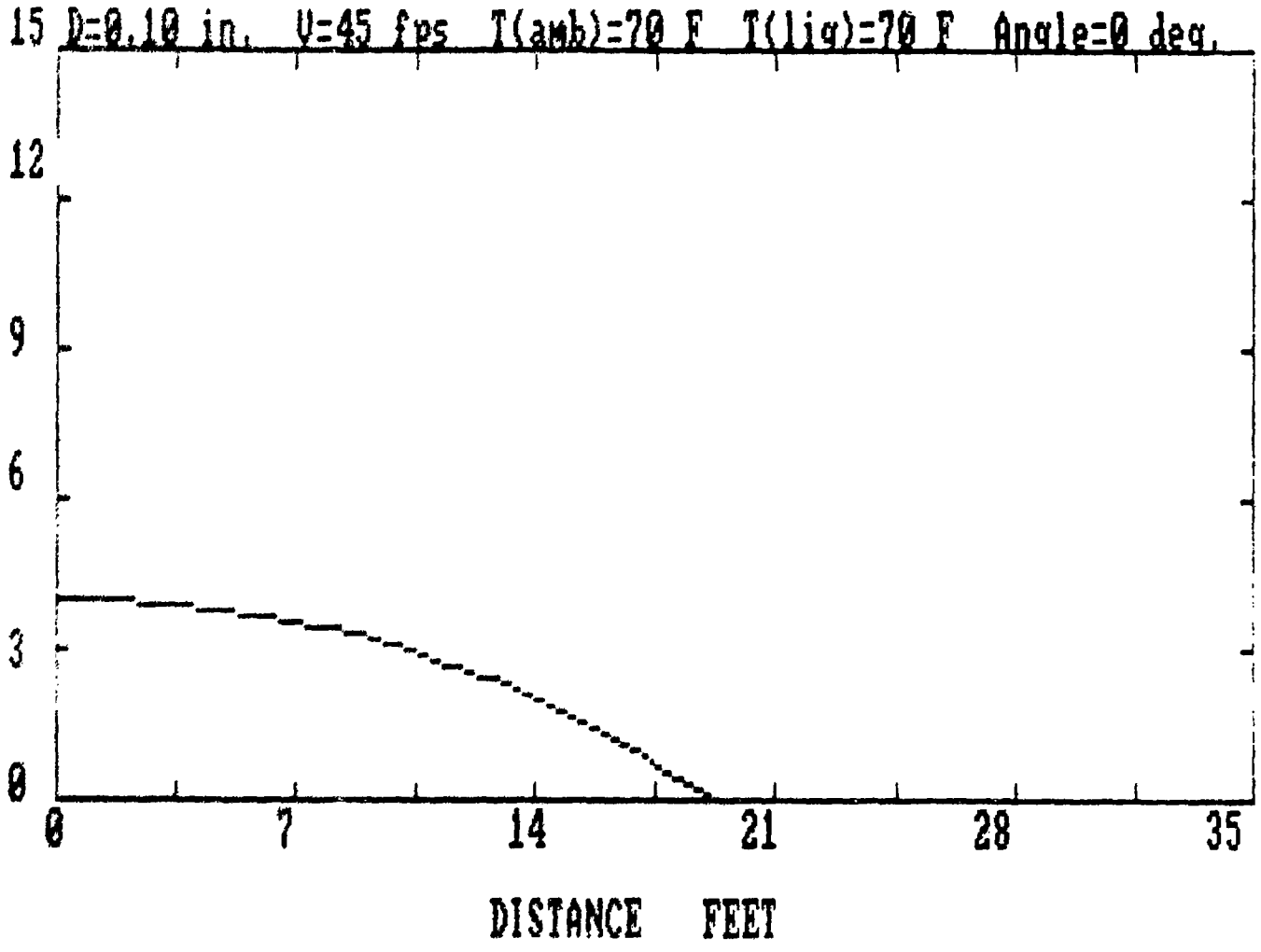

Figure C-13. Calculated Trajectory for Droplet with Liquid Temperature = 70 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

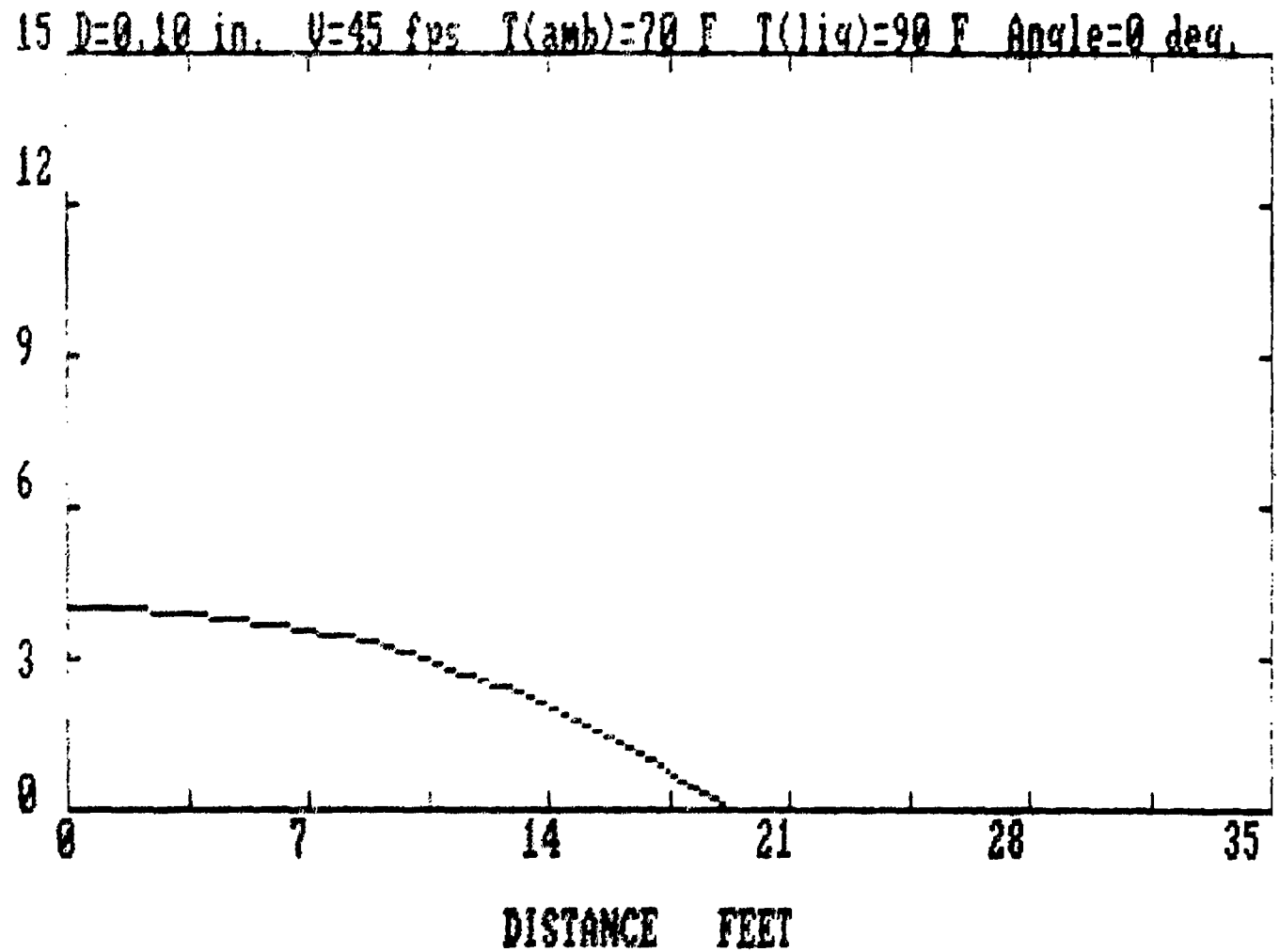

Figure C-14. Calculated Trajectory for Droplet with Liquid Temperature = 90 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

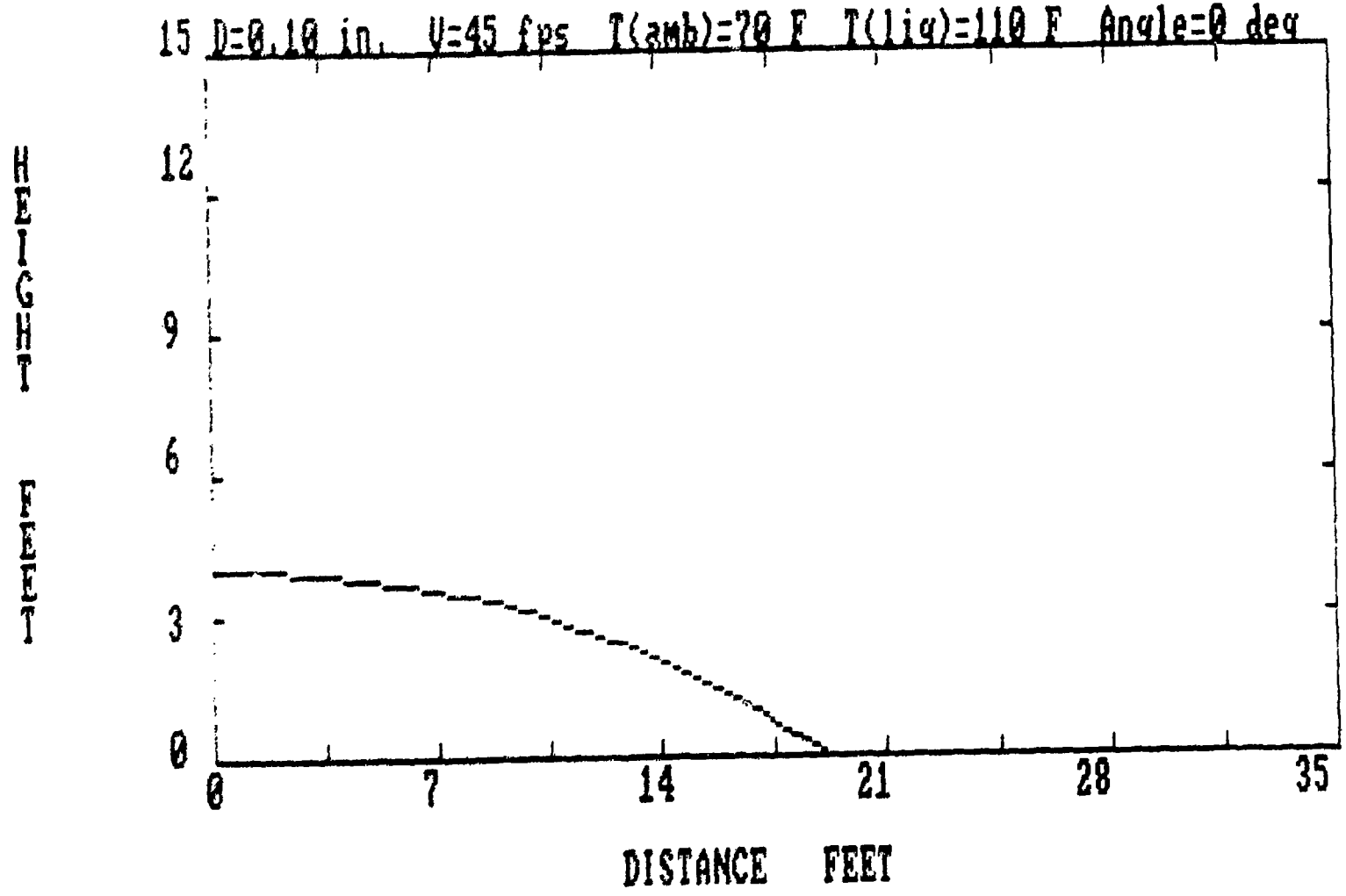

Figure C-15. Calculated Trajectory for Droplet with Liquid Temperature = 110 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

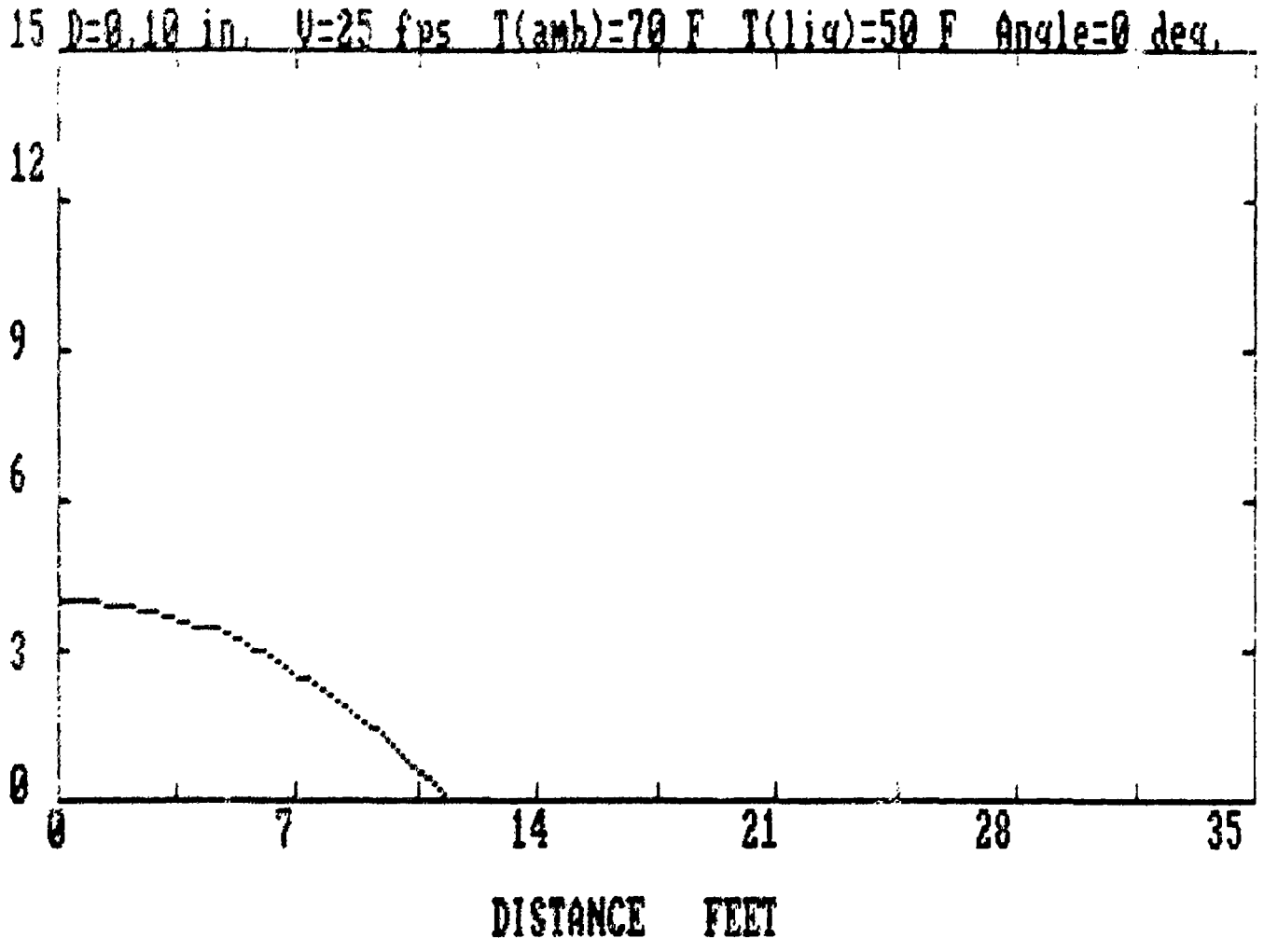

Figure C-16. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 25 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

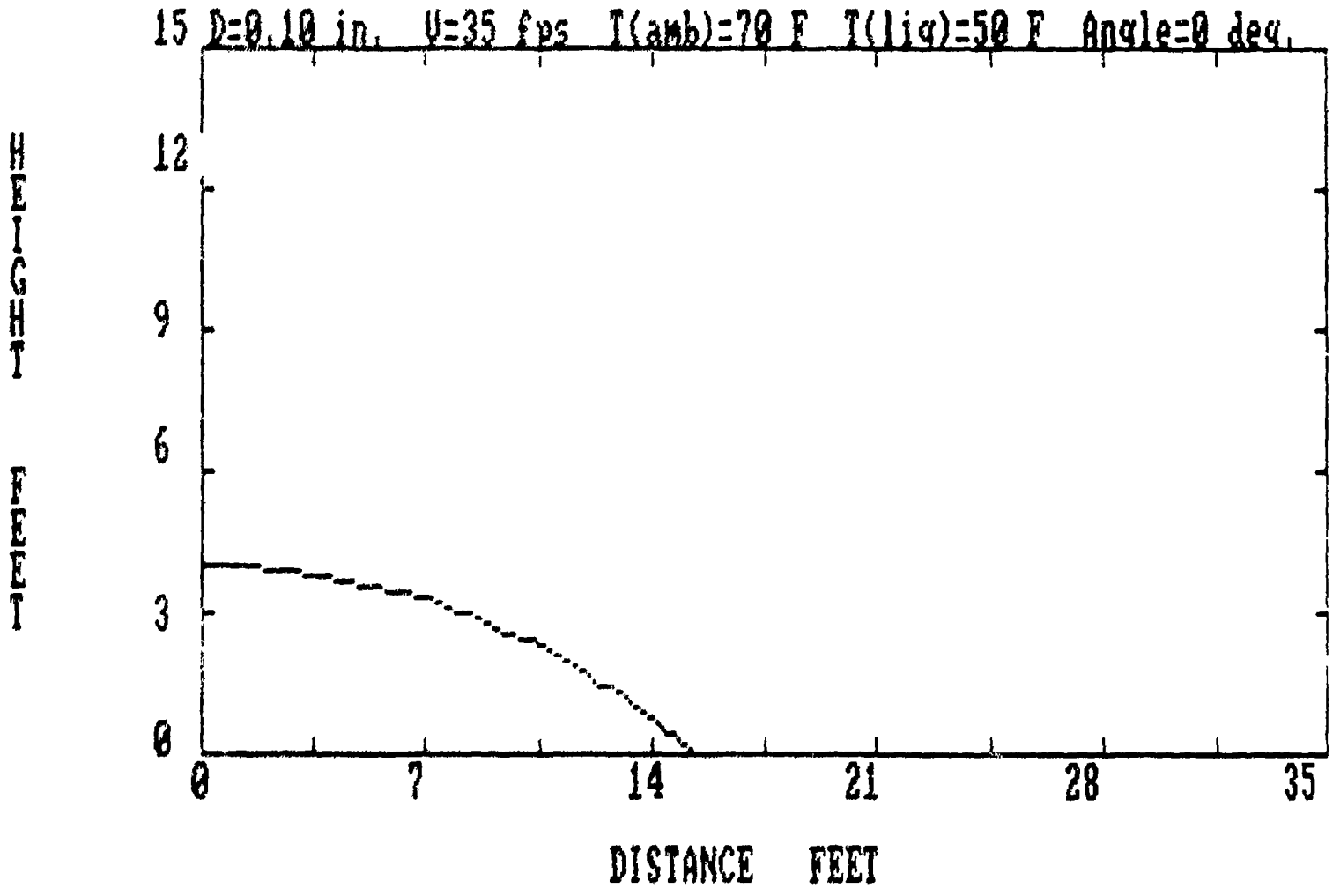

Figure C-17. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 35 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

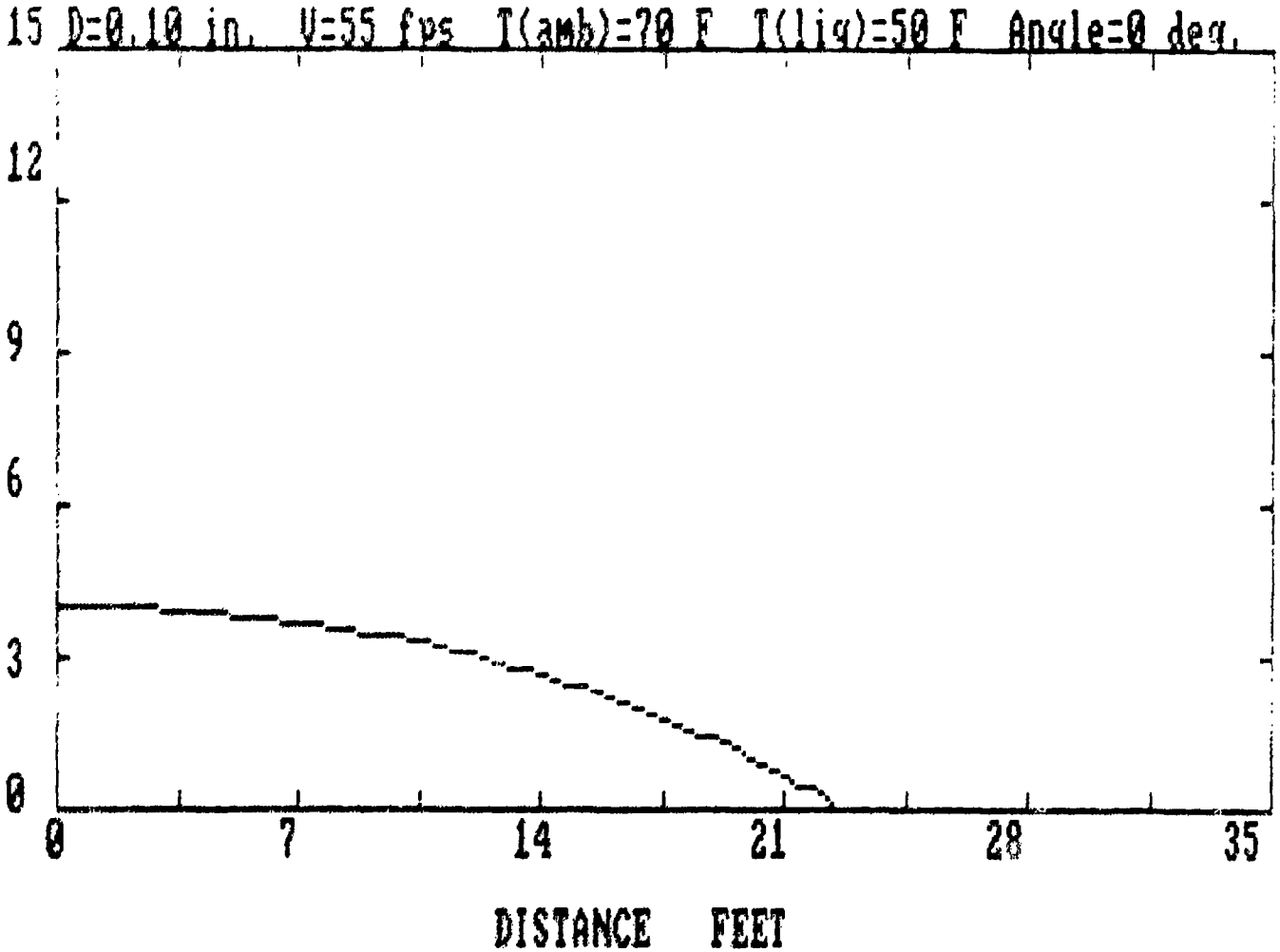

Figure C-18. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 55 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

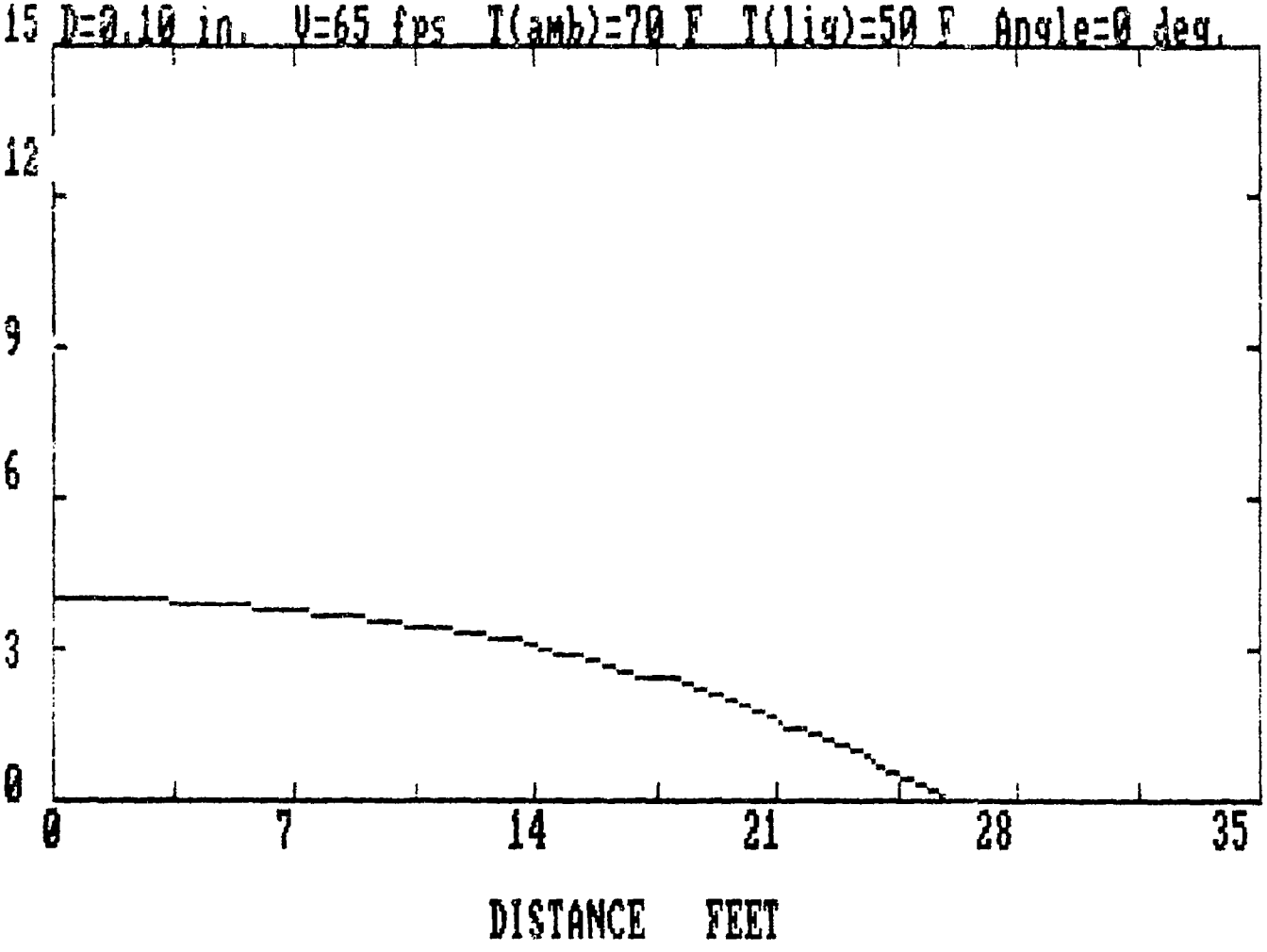

Figure C-19. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 65 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

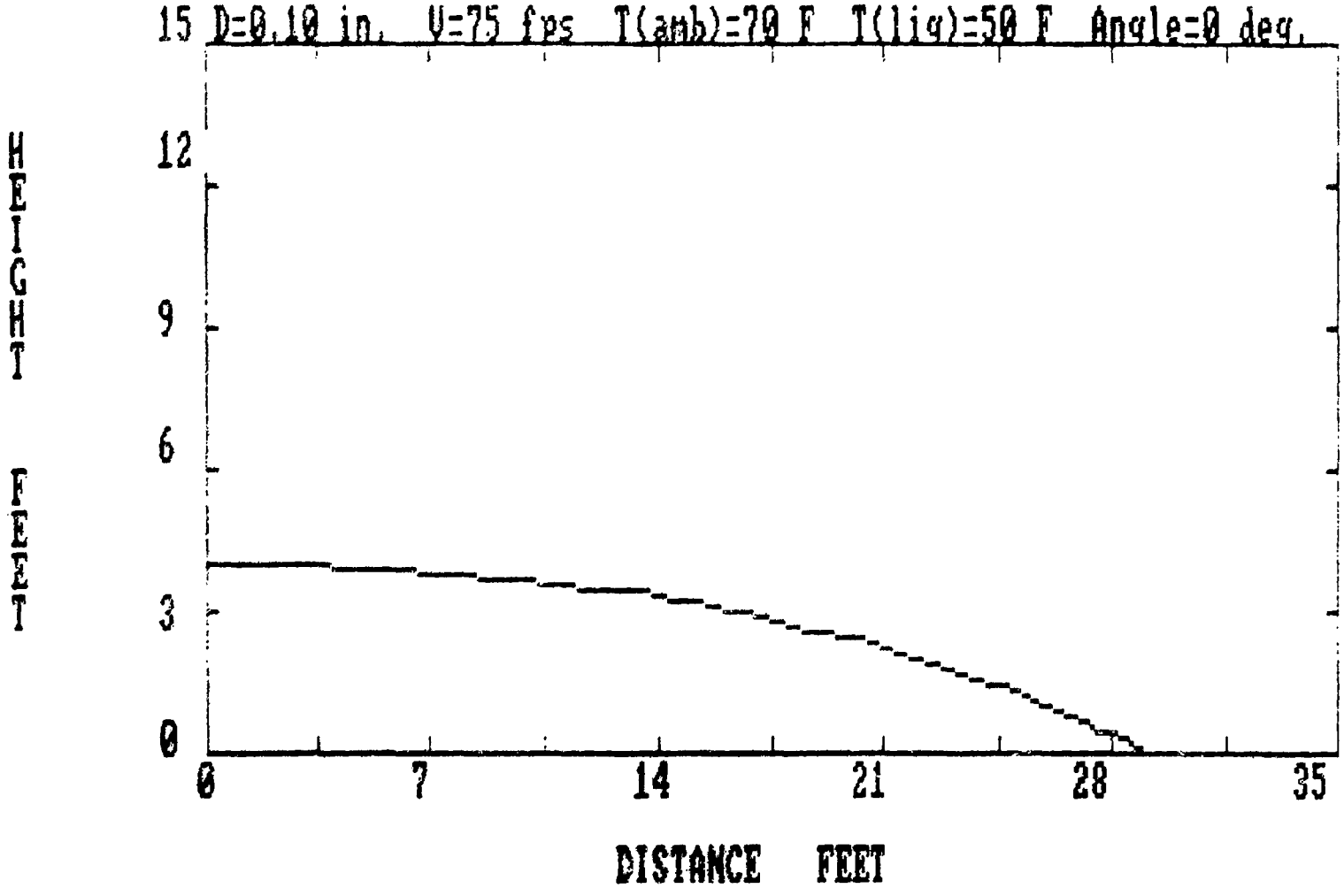

Figure C-20. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 75 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

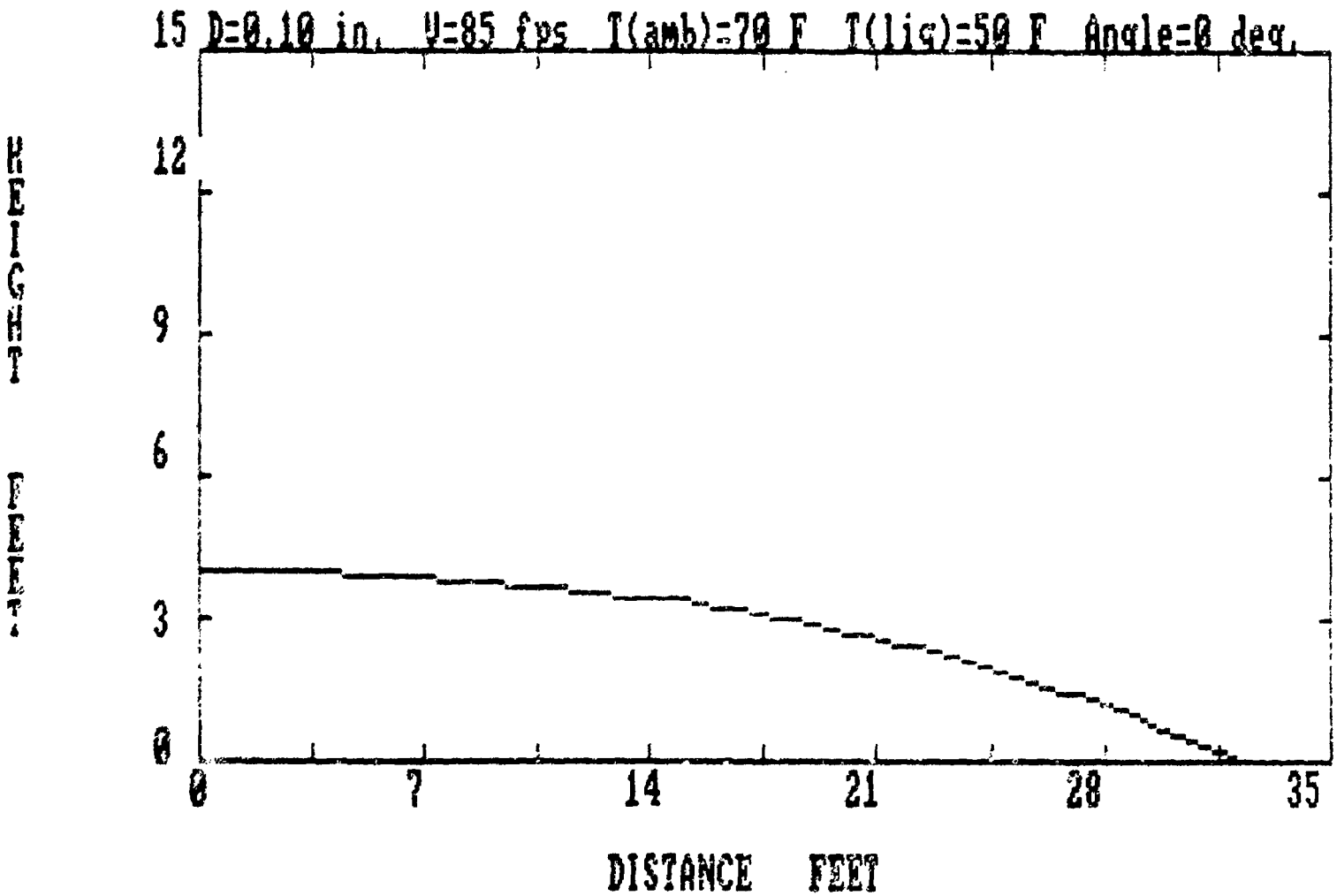

Figure C-21. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 85 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

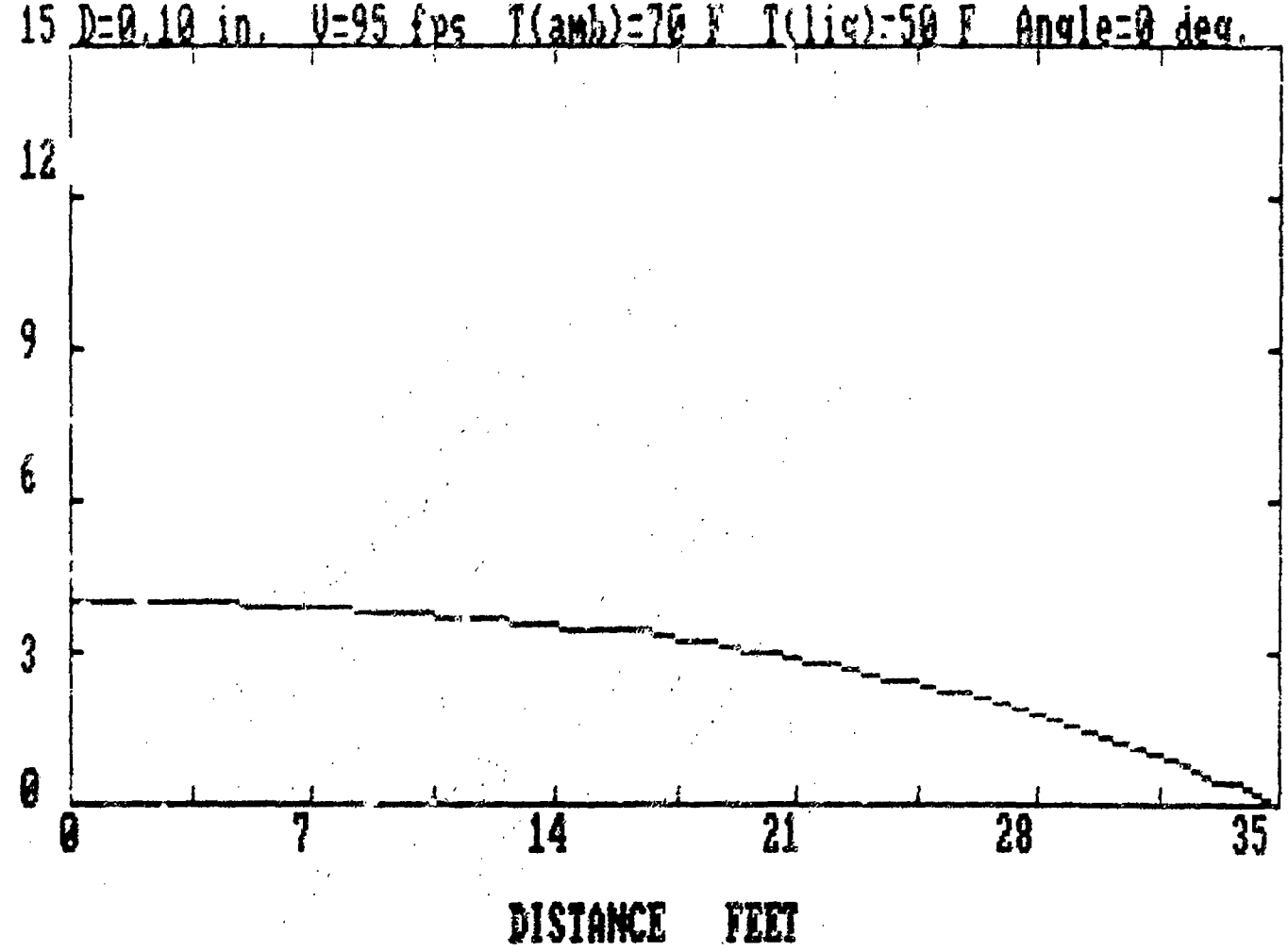

Figure C-2. Calculated Trajectory for Droplet with Liquid Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 95 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

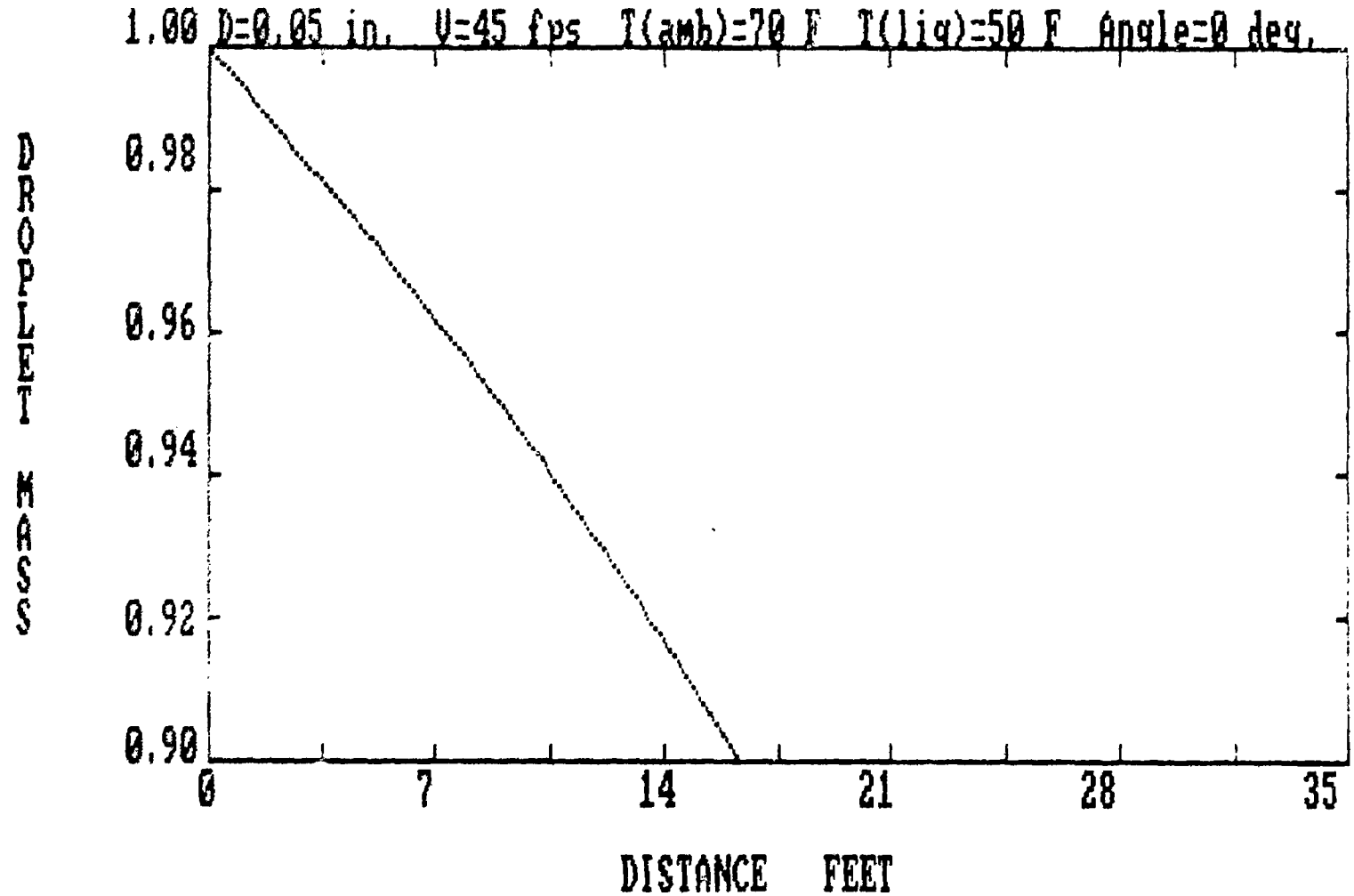

Figure C-23. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.05 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

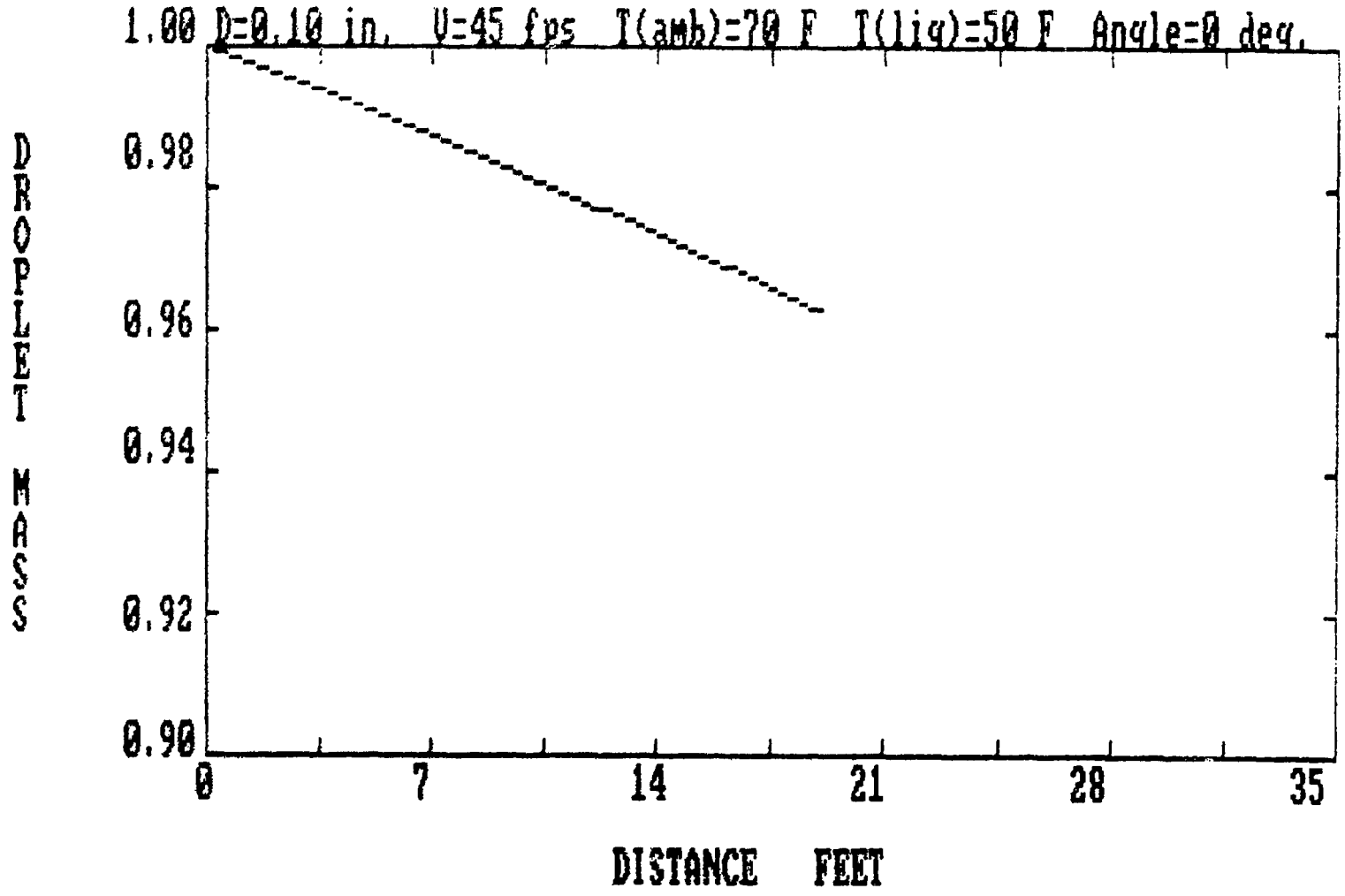

Figure C-24. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

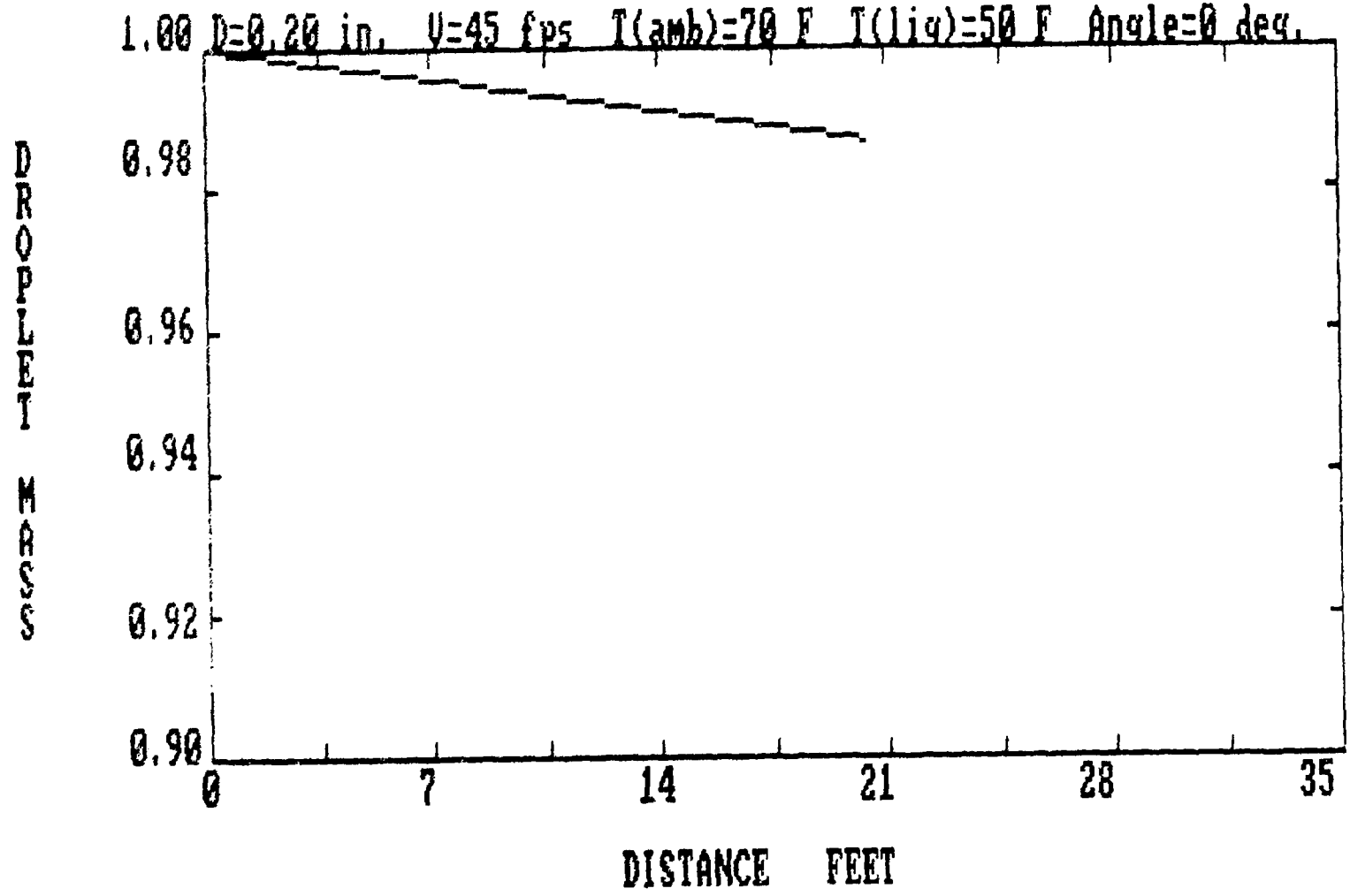

Figure C-25. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.20 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

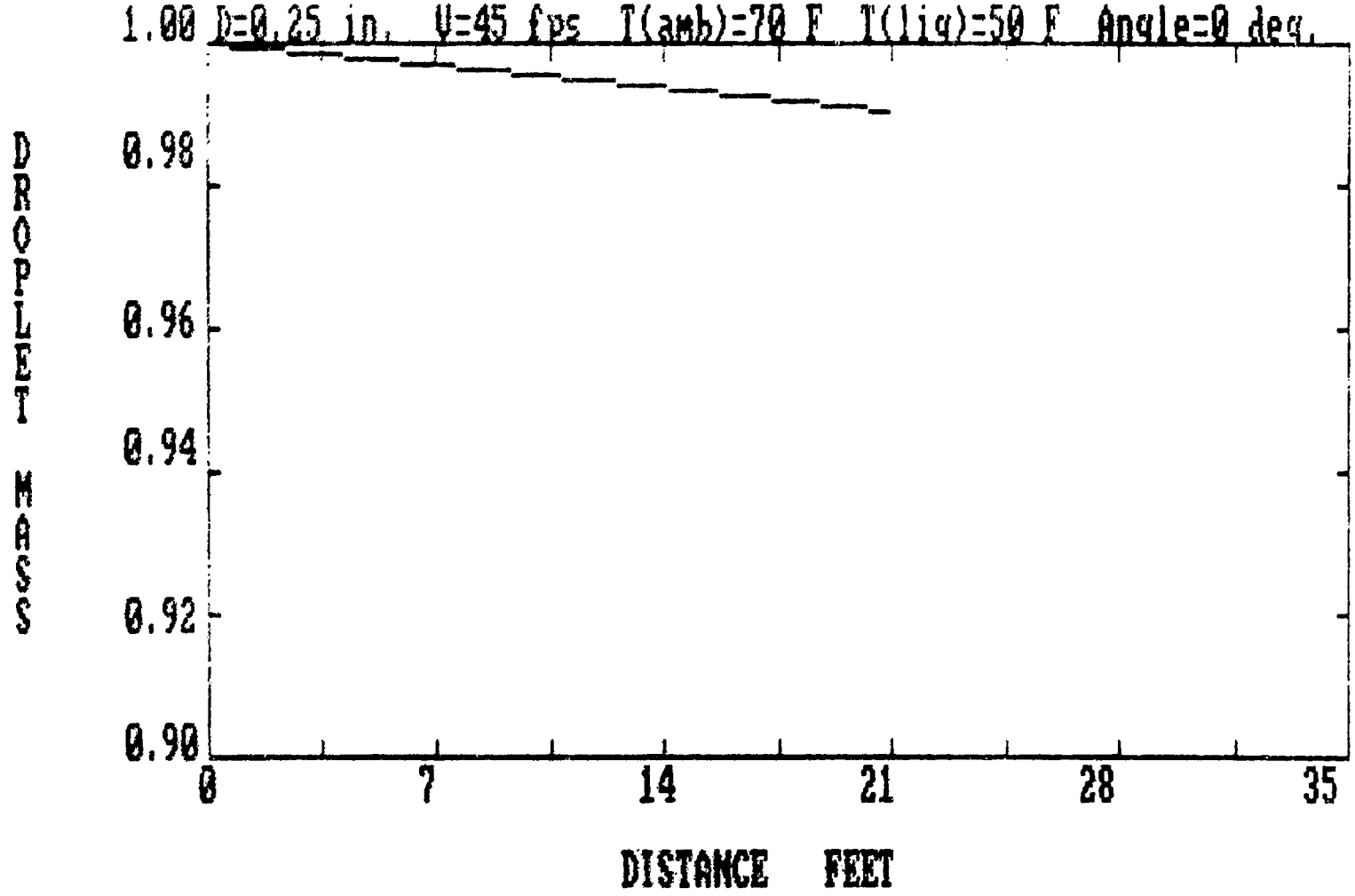

Figure C-26. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.25 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

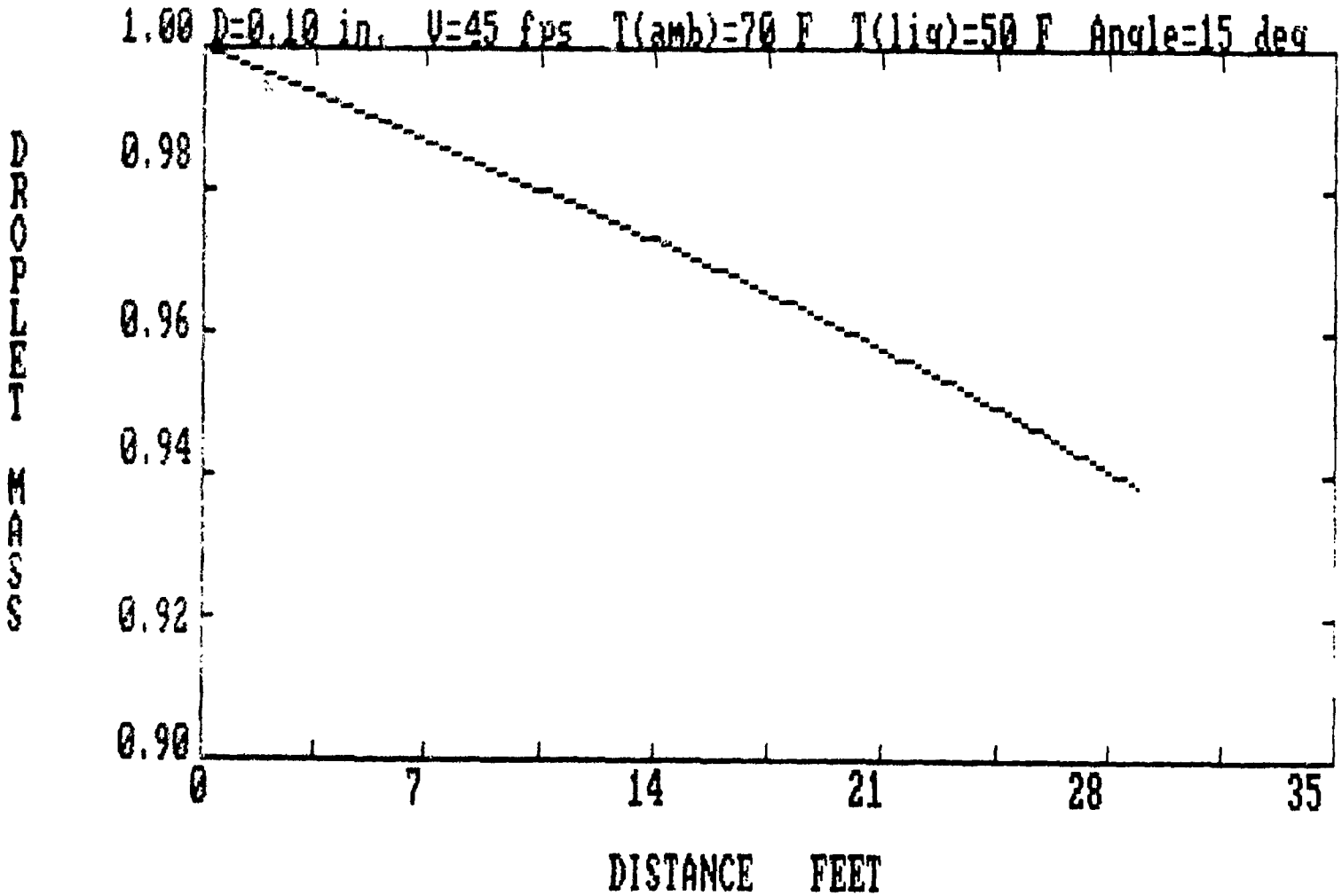

Figure C-27. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 15 Degrees.

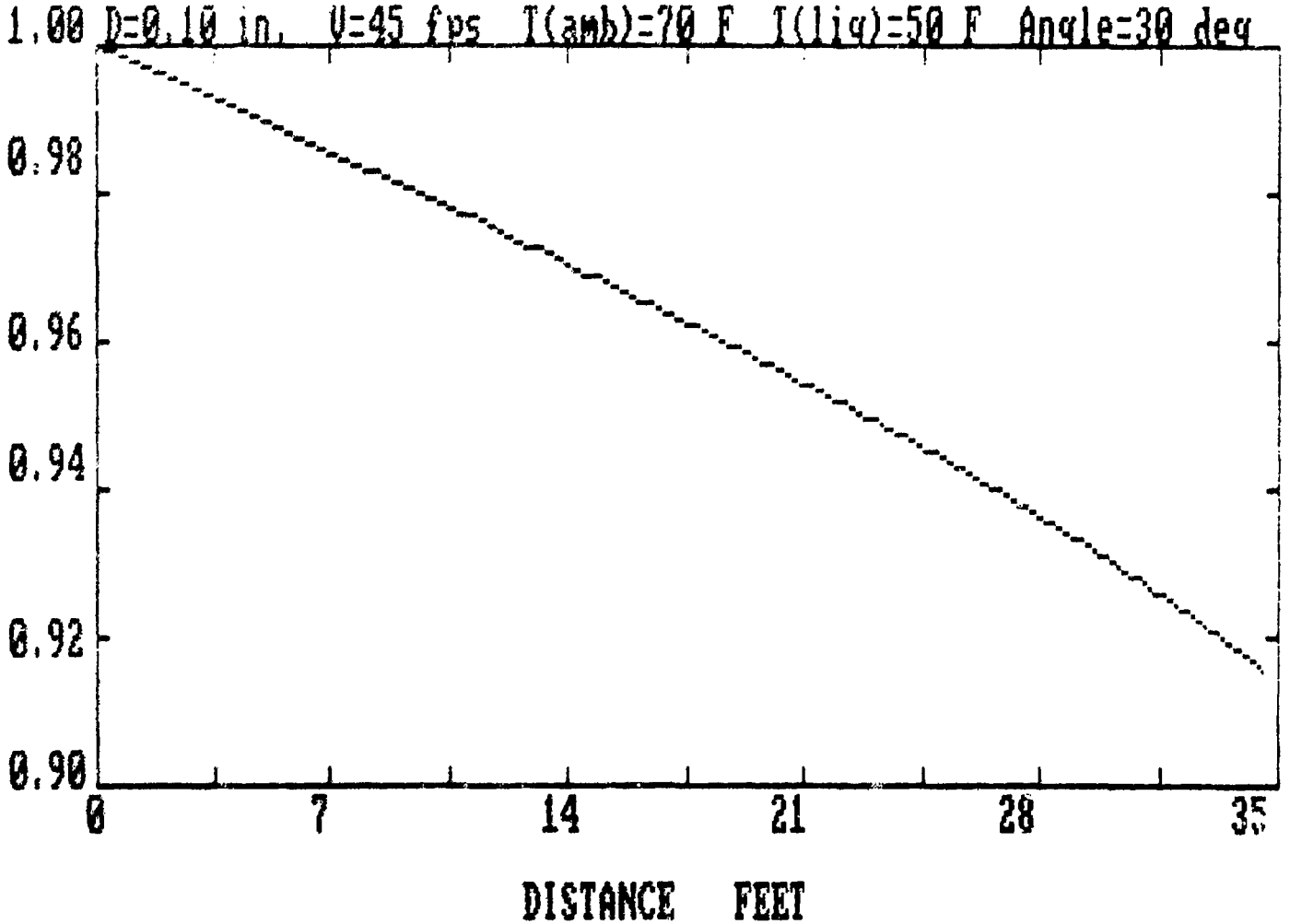

Figure C-28. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 30 Degrees.

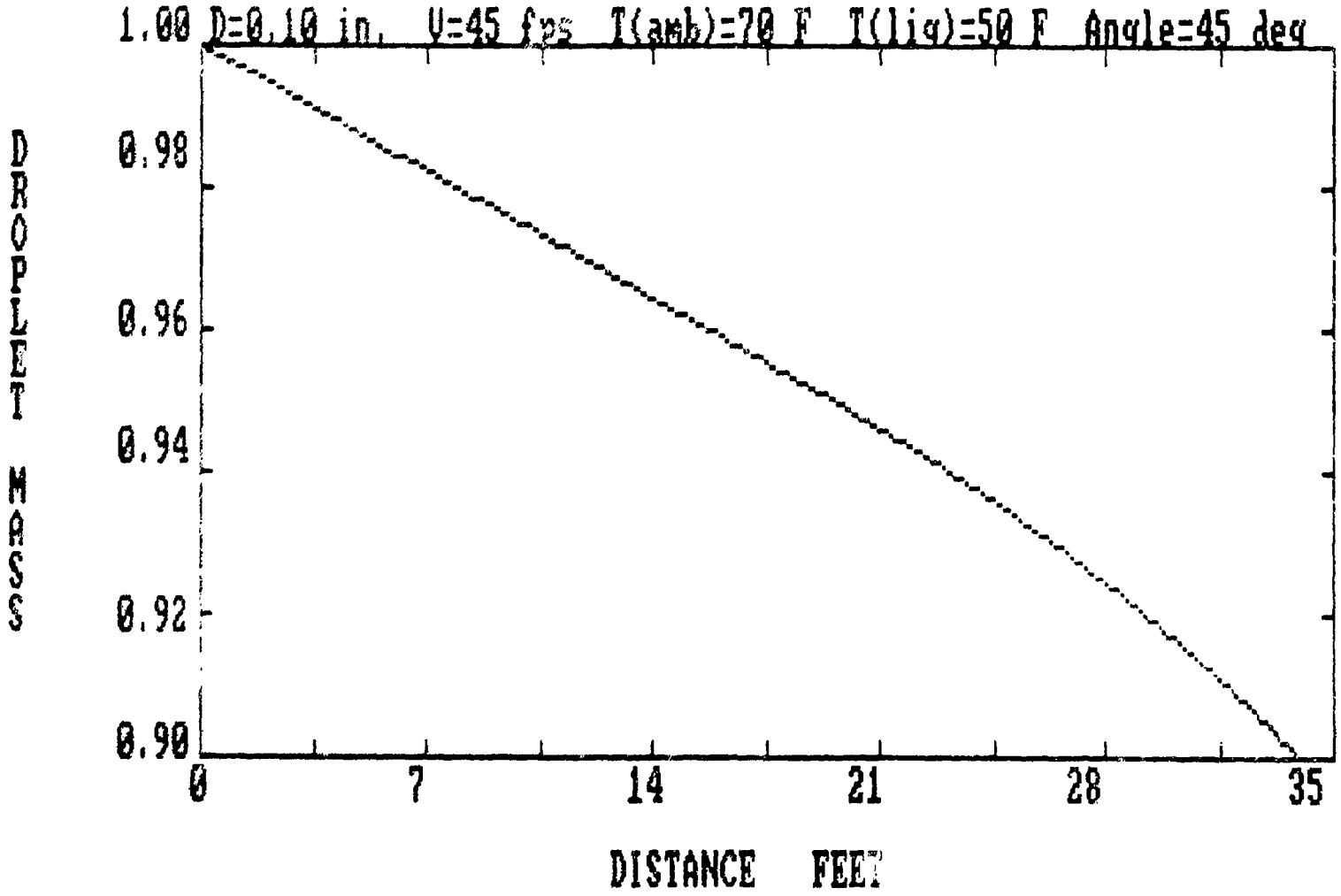

Figure C-29. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 45 Degrees.

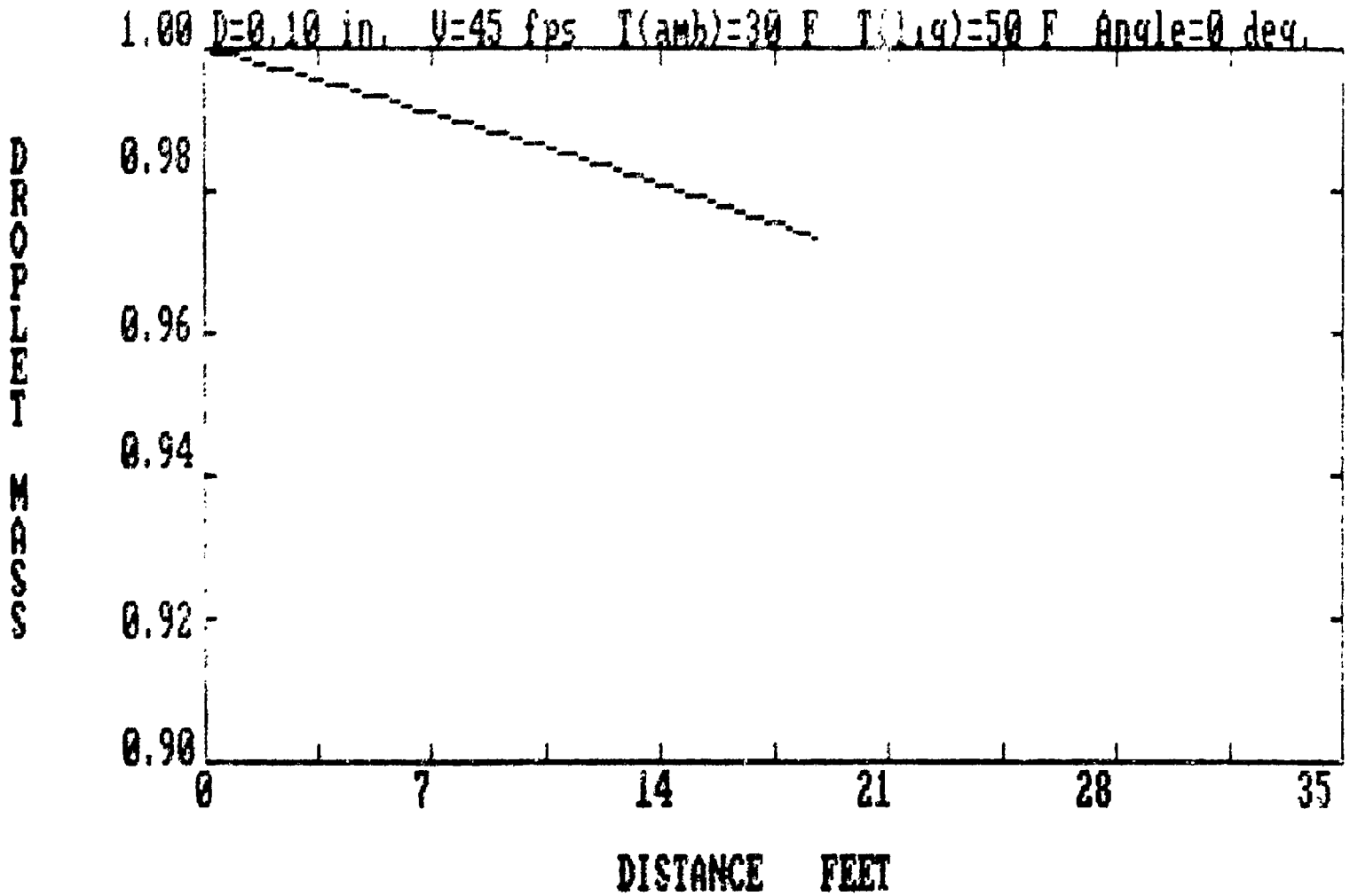

Figure C-30. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 30 °F, and Nozzle Angle = 0 Degrees.

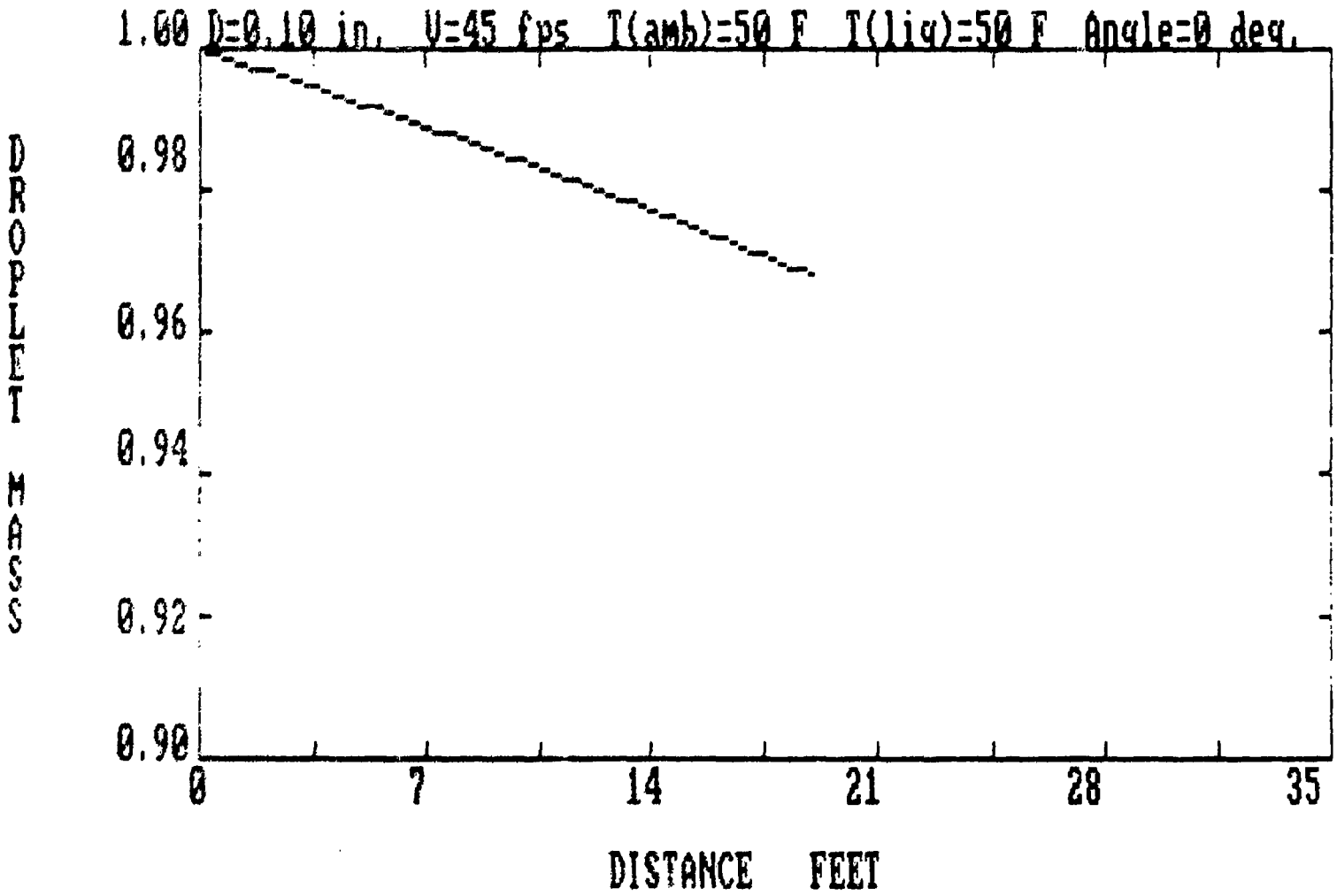

Figure C-31. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 50 °F, and Nozzle Angle = 0 Degrees.

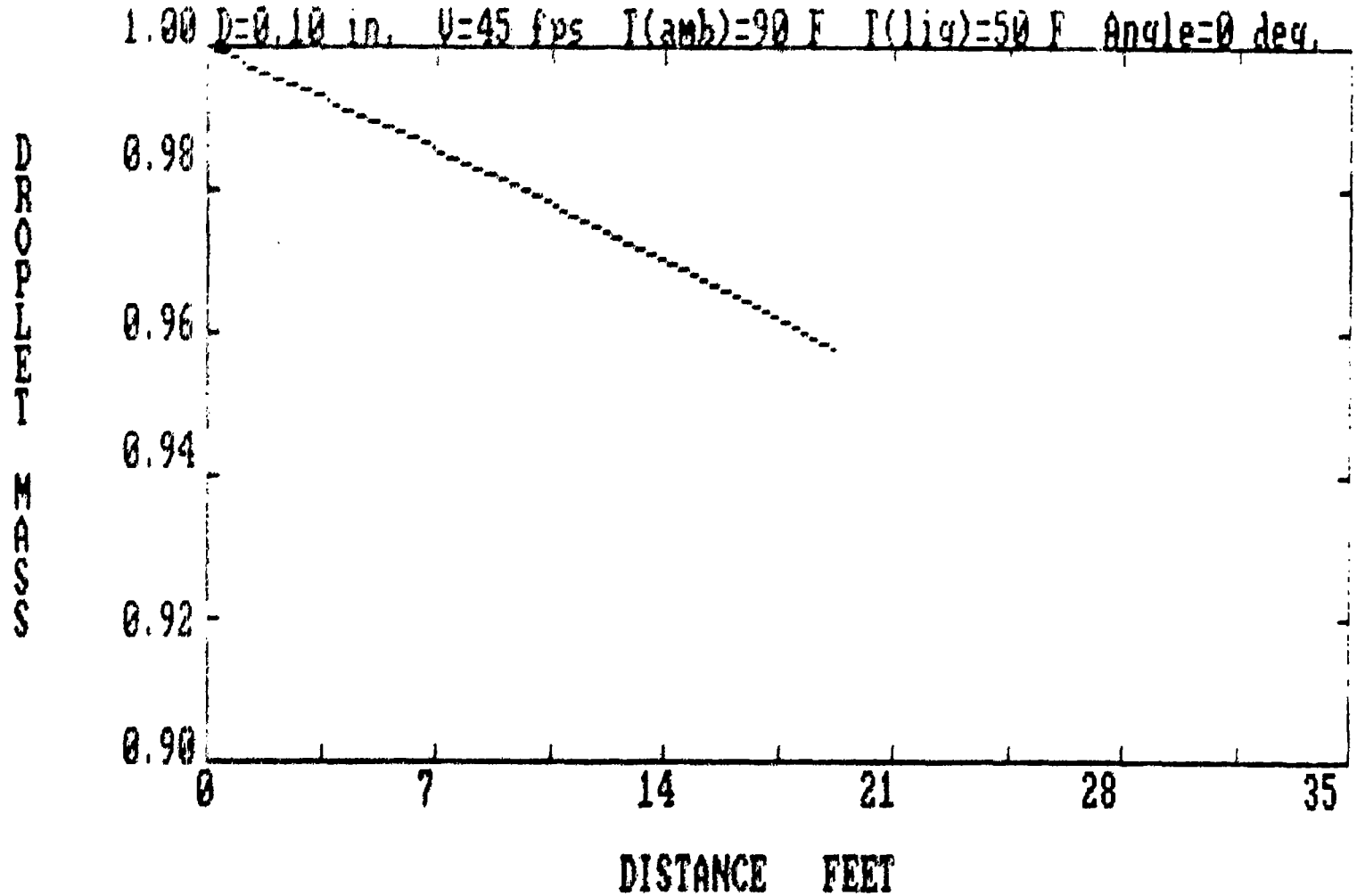

Figure C-32. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 90 °F, and Nozzle Angle = 0 Degrees.

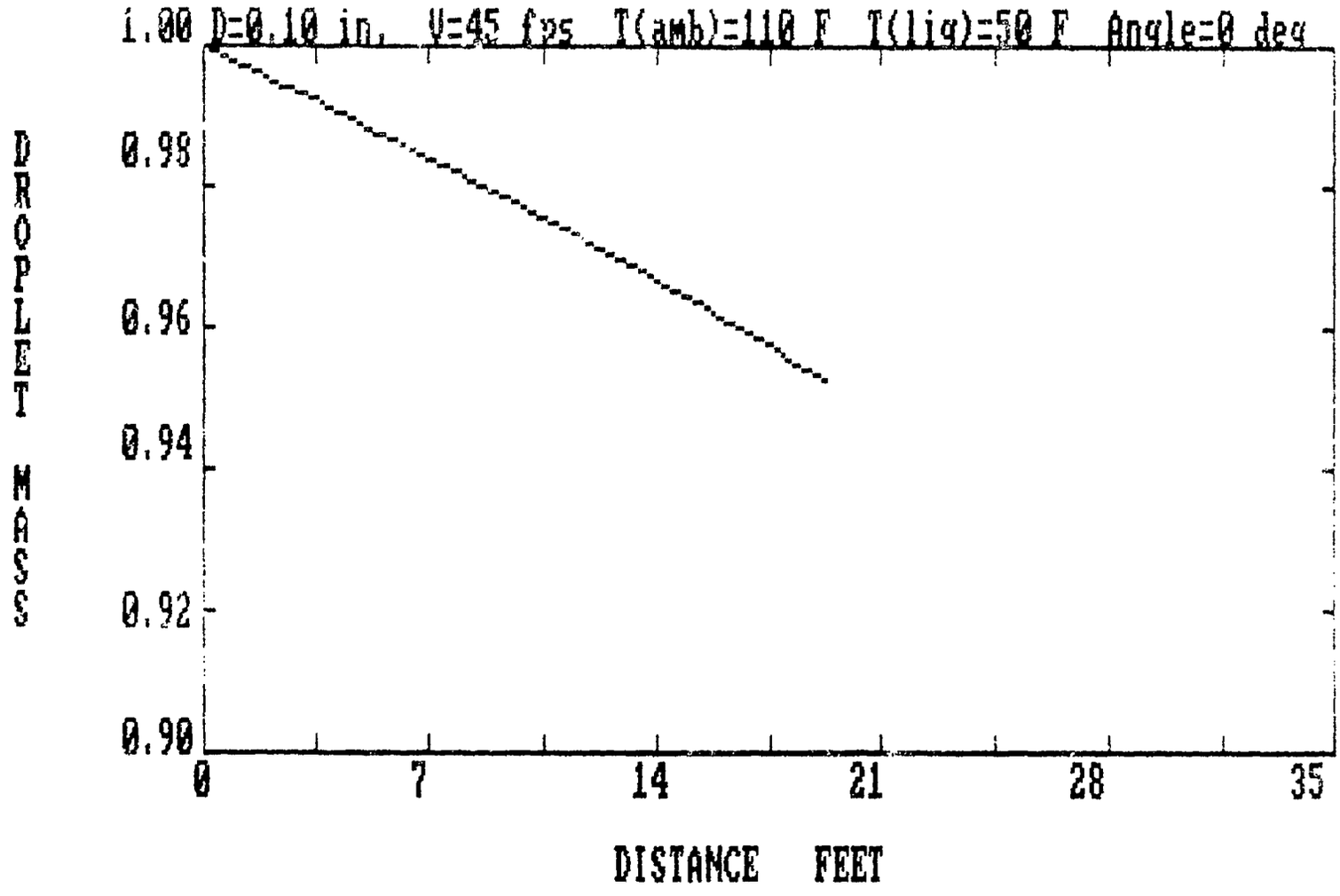

Figure C-33. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 110 °F, and Nozzle Angle = 0 Degrees.

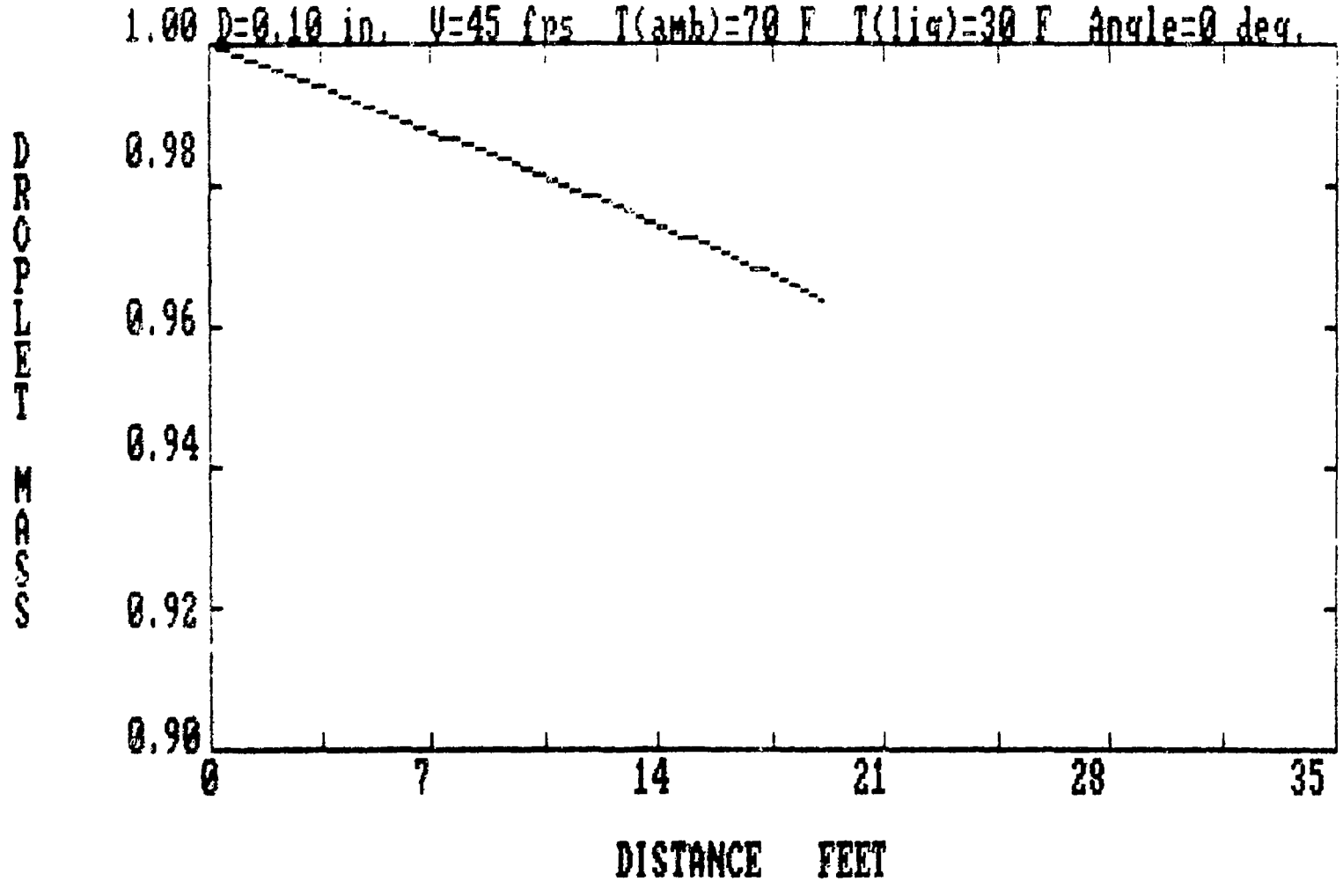

Figure C-34. Calculated Mass Ratio Change for Droplet with Temperature = 30 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

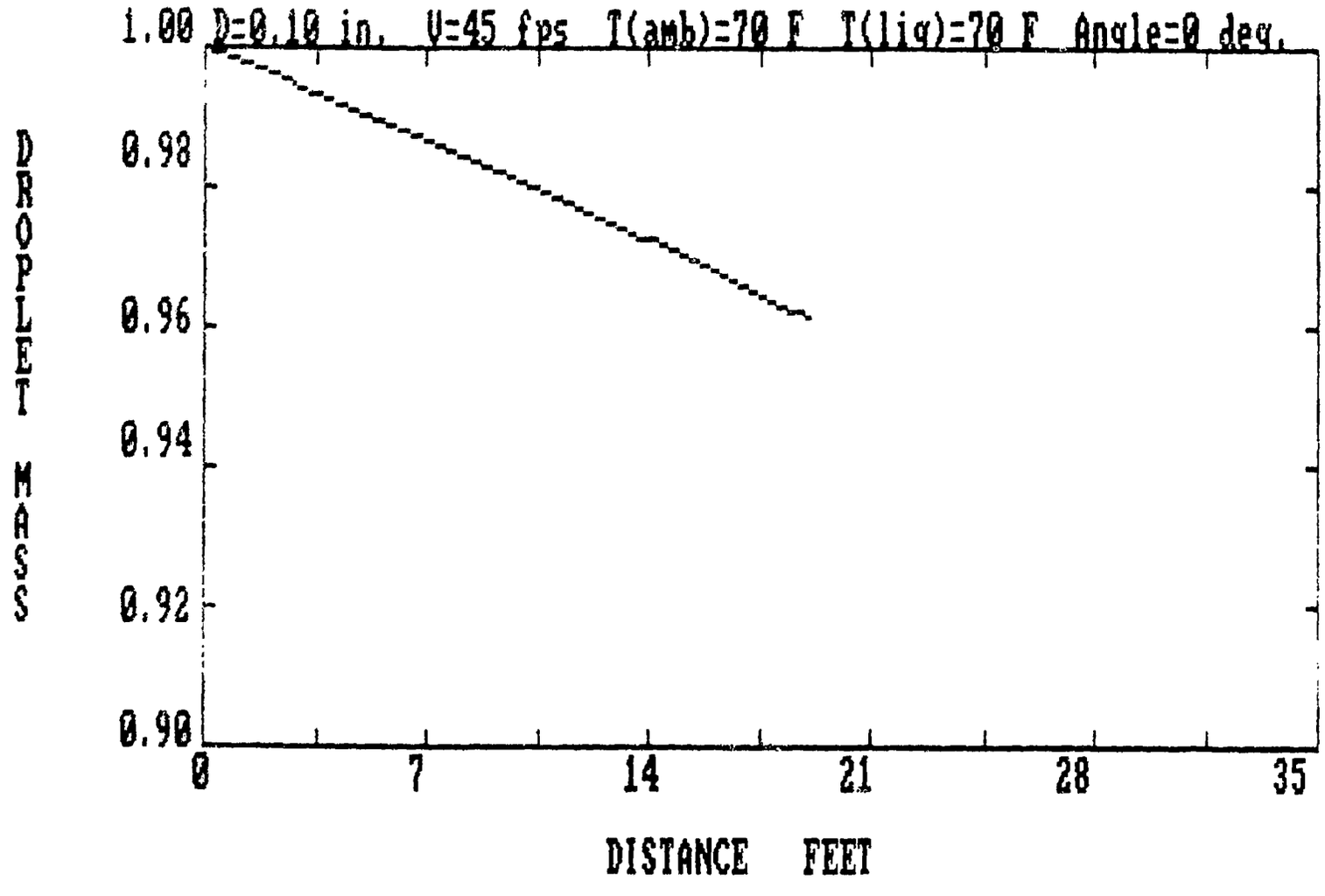

Figure C-35. Calculated Mass Ratio Change for Droplet with Temperature = 70 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

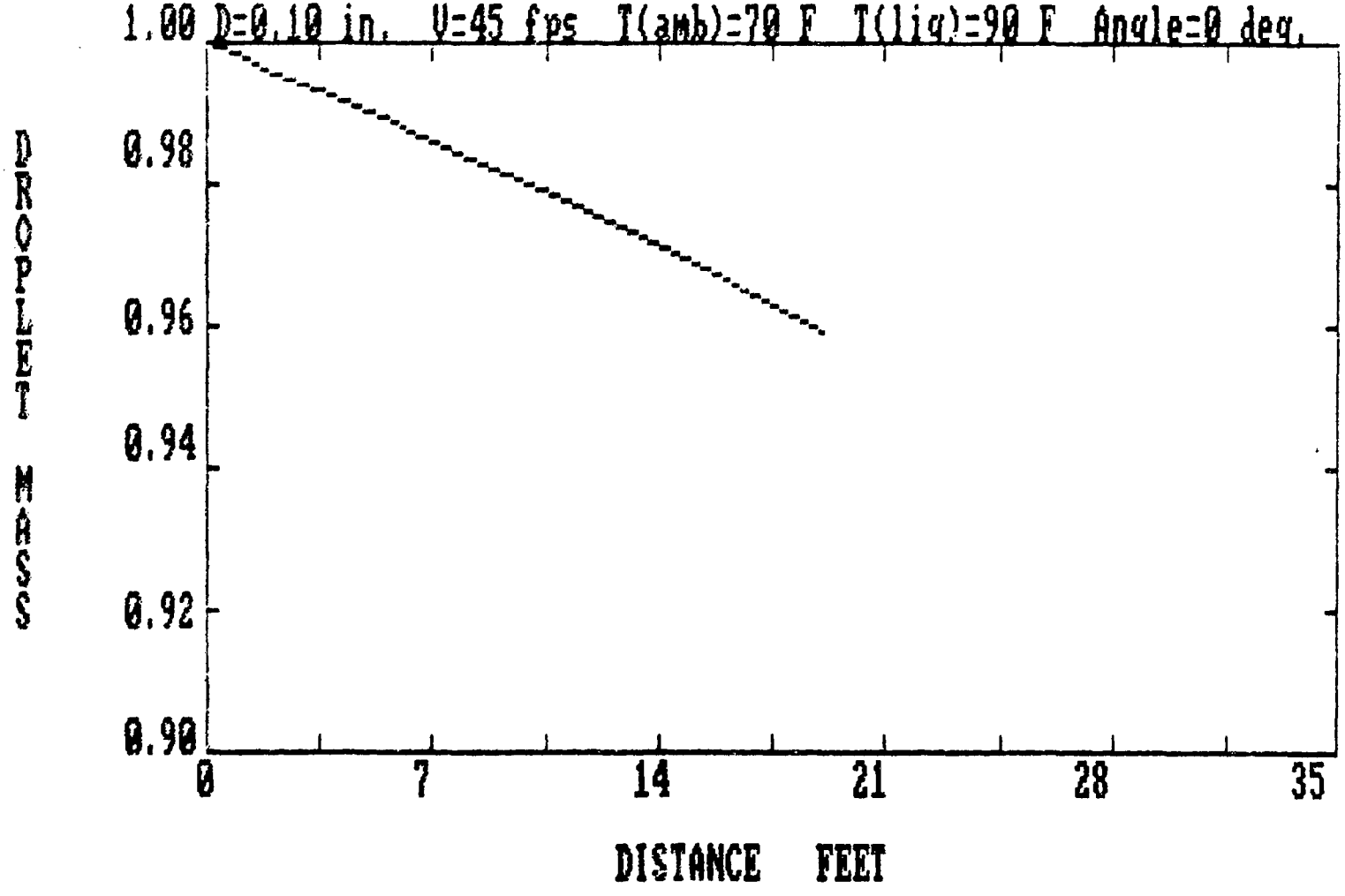

Figure C-36. Calculated Mass Ratio Change for Droplet with Temperature = 90 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

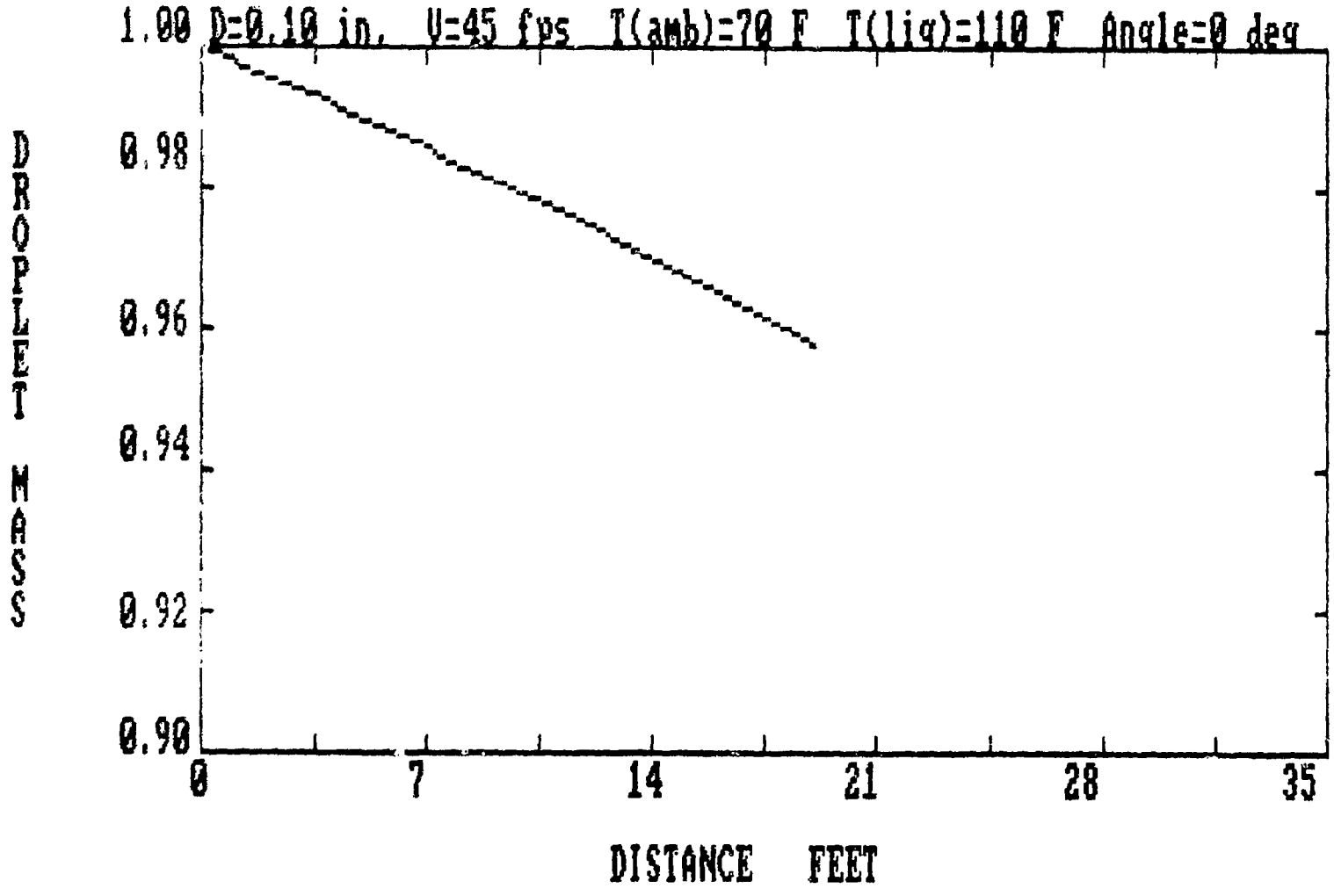

Figure C-37. Calculated Mass Ratio Change for Droplet with Temperature = 110 °F, Drop Diameter = 0.10 Inch, Velocity = 45 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

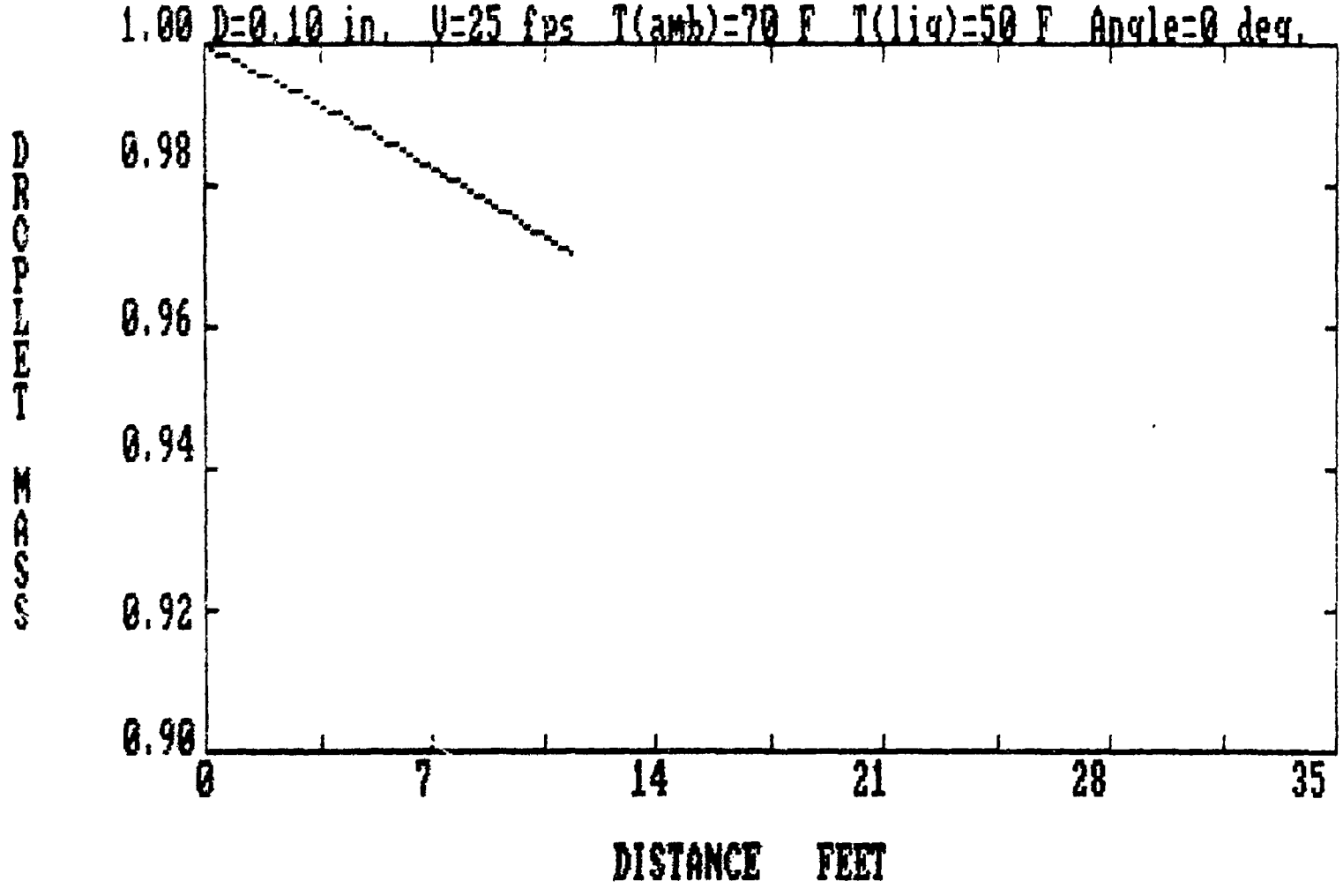

Figure C-38. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 25 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

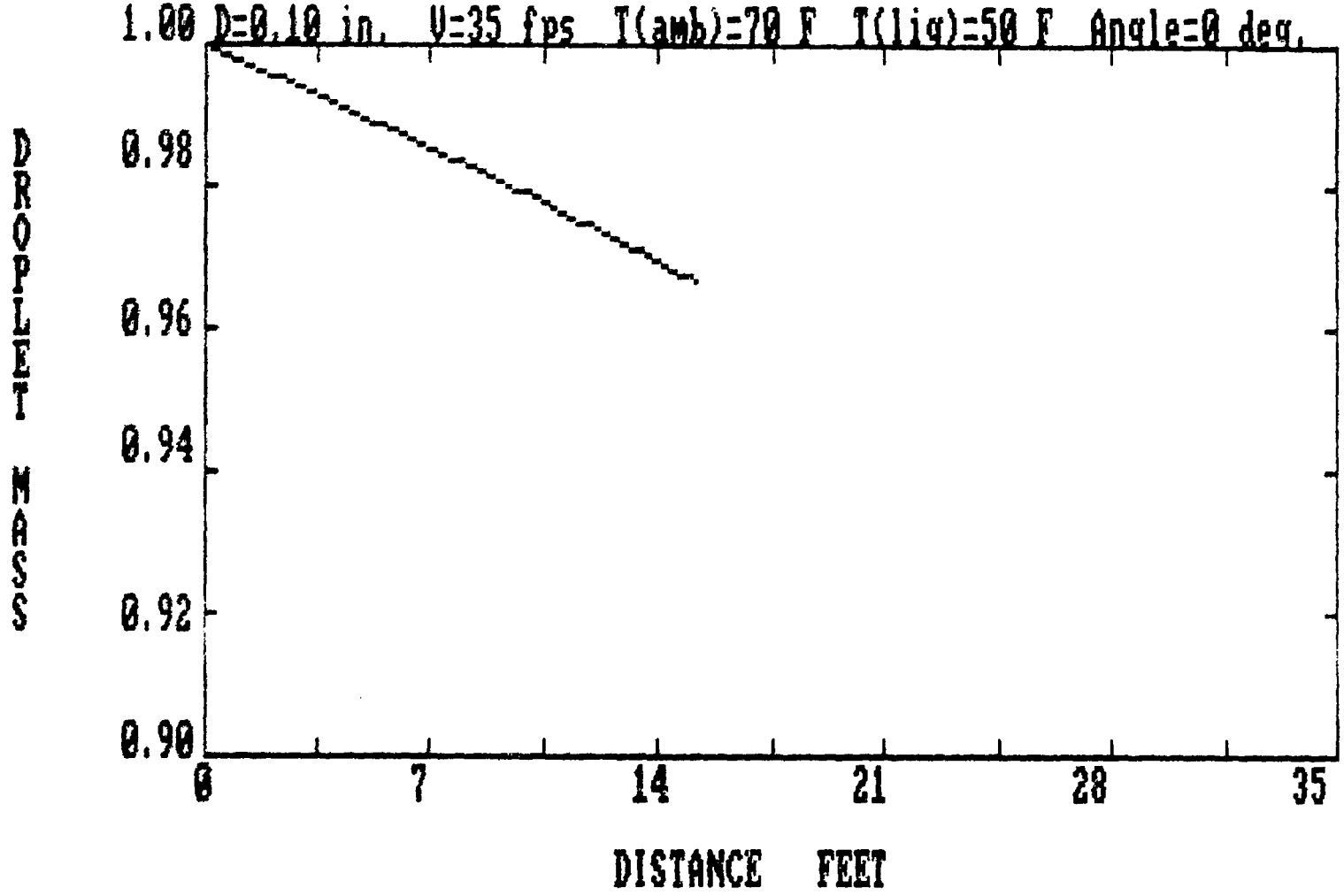

Figure C-39. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 35 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

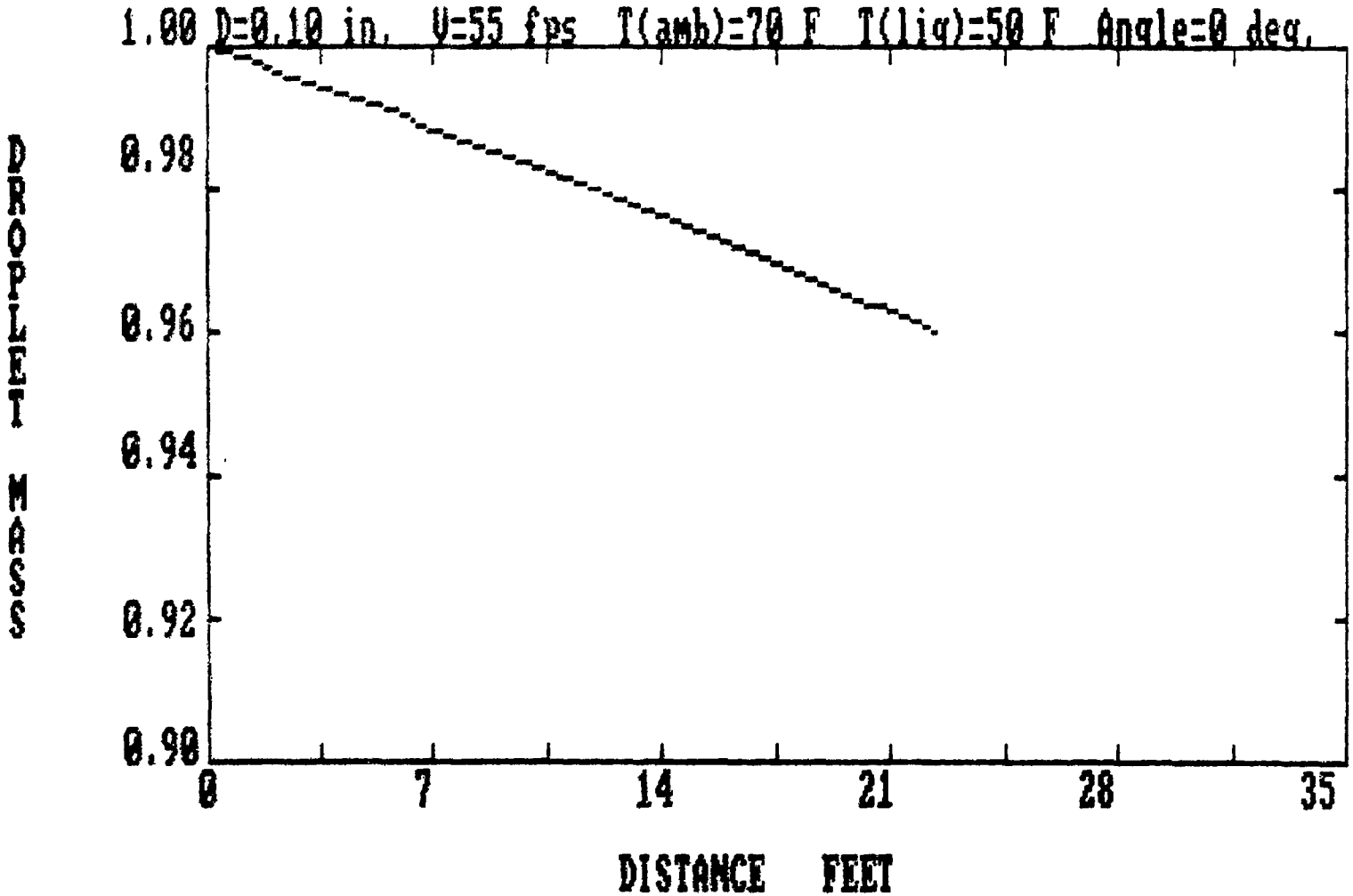

Figure C-40. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 55 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

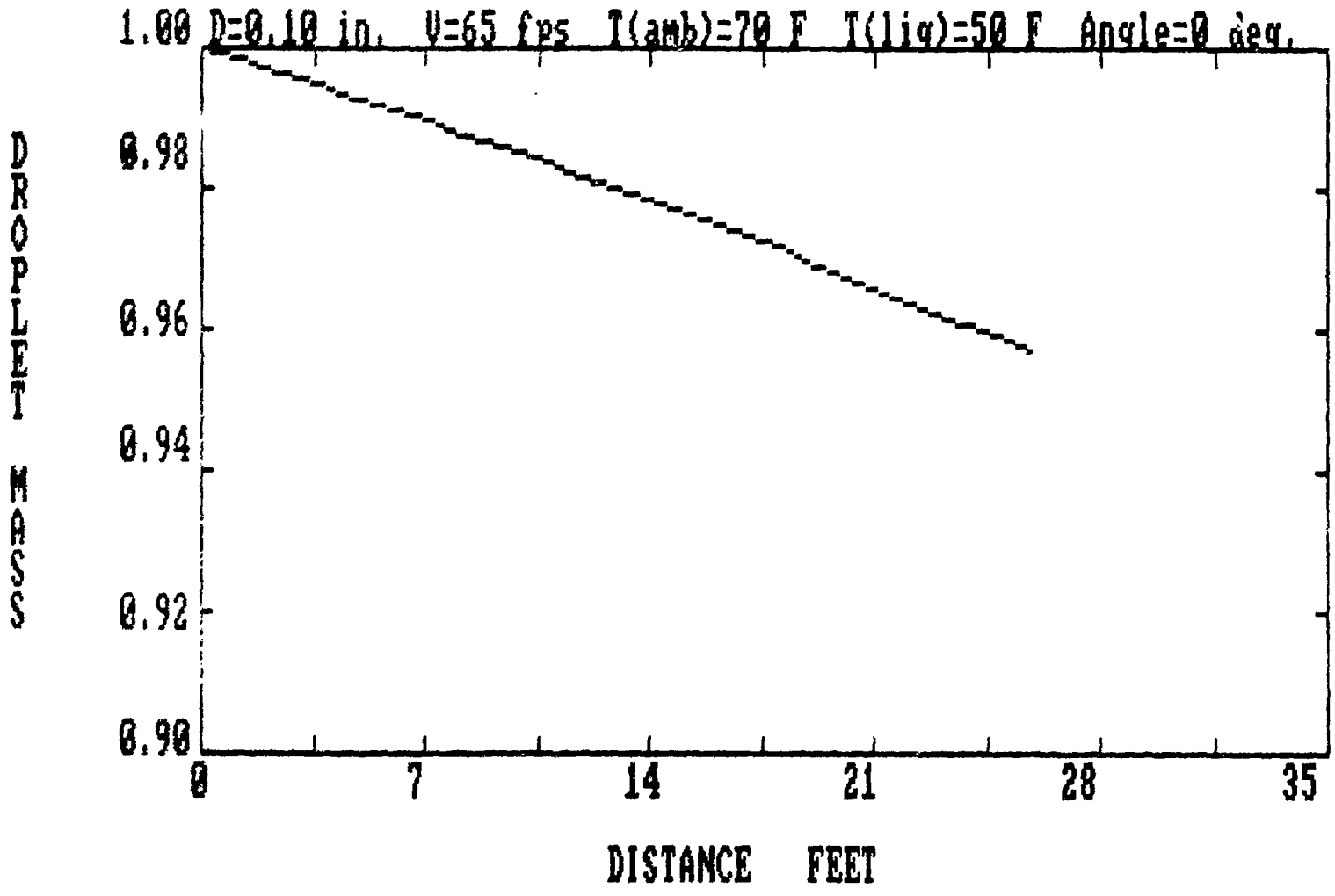

Figure C-41. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 65 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

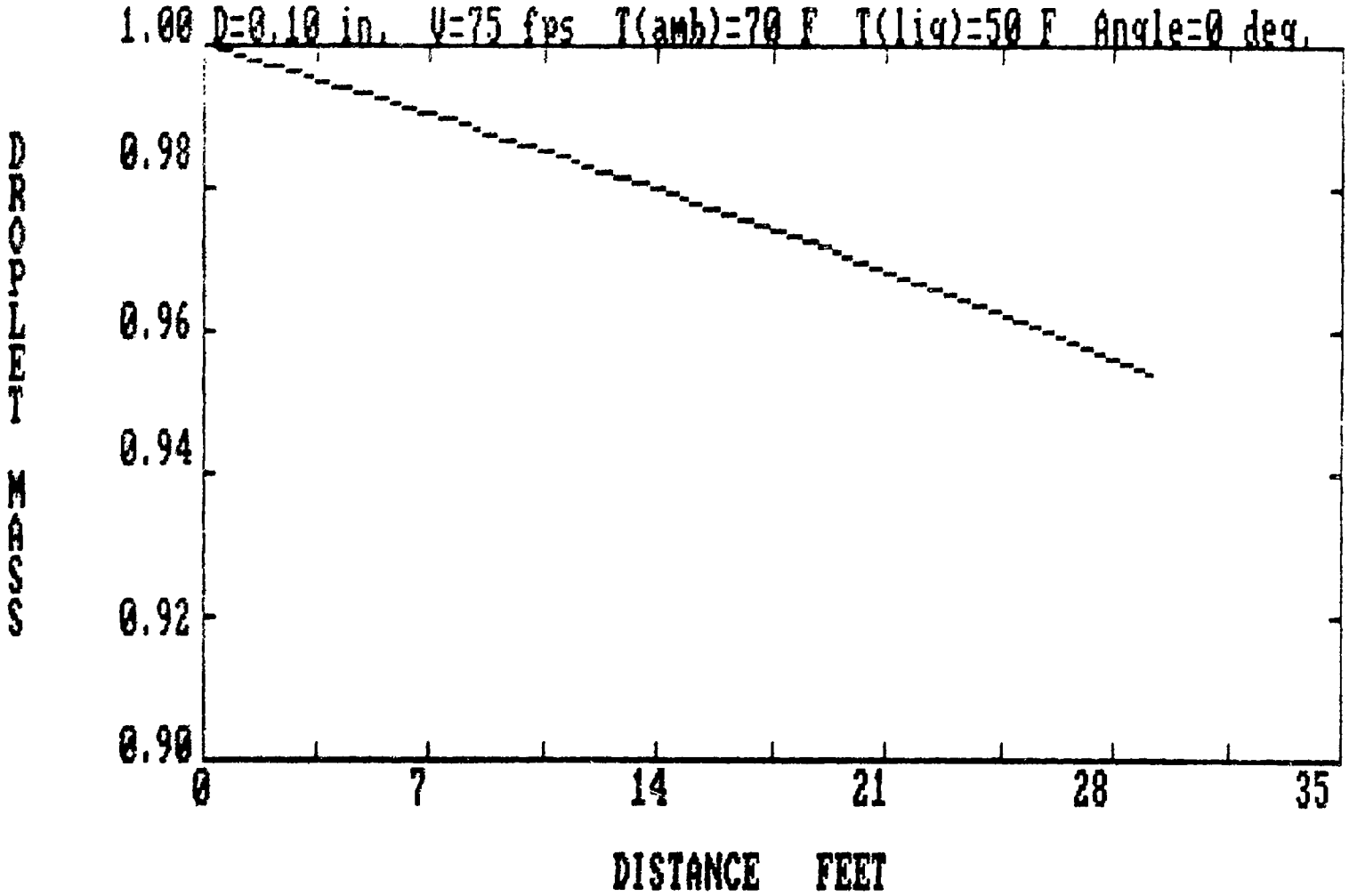

Figure C-42. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 75 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

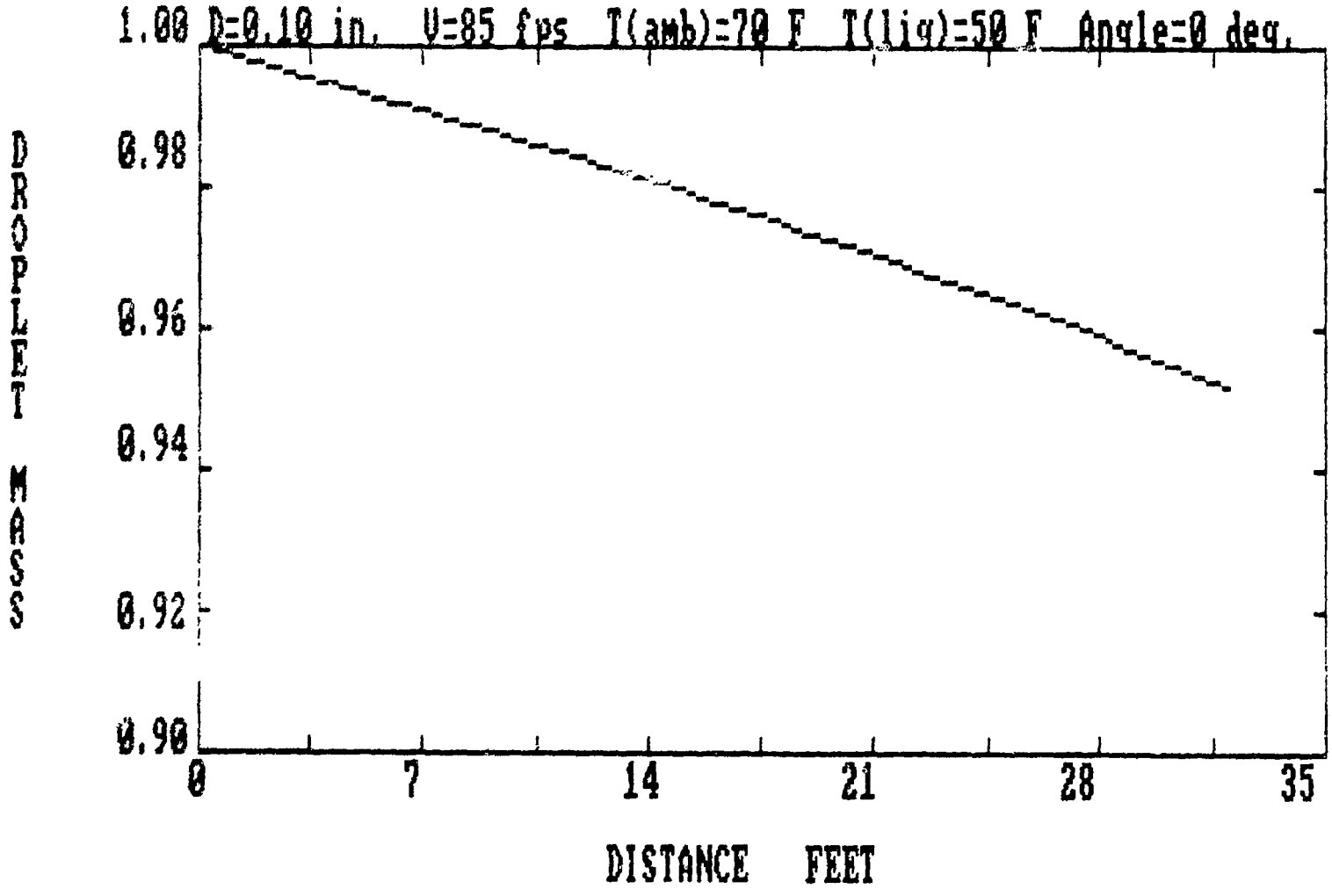

Figure C-43. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 85 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

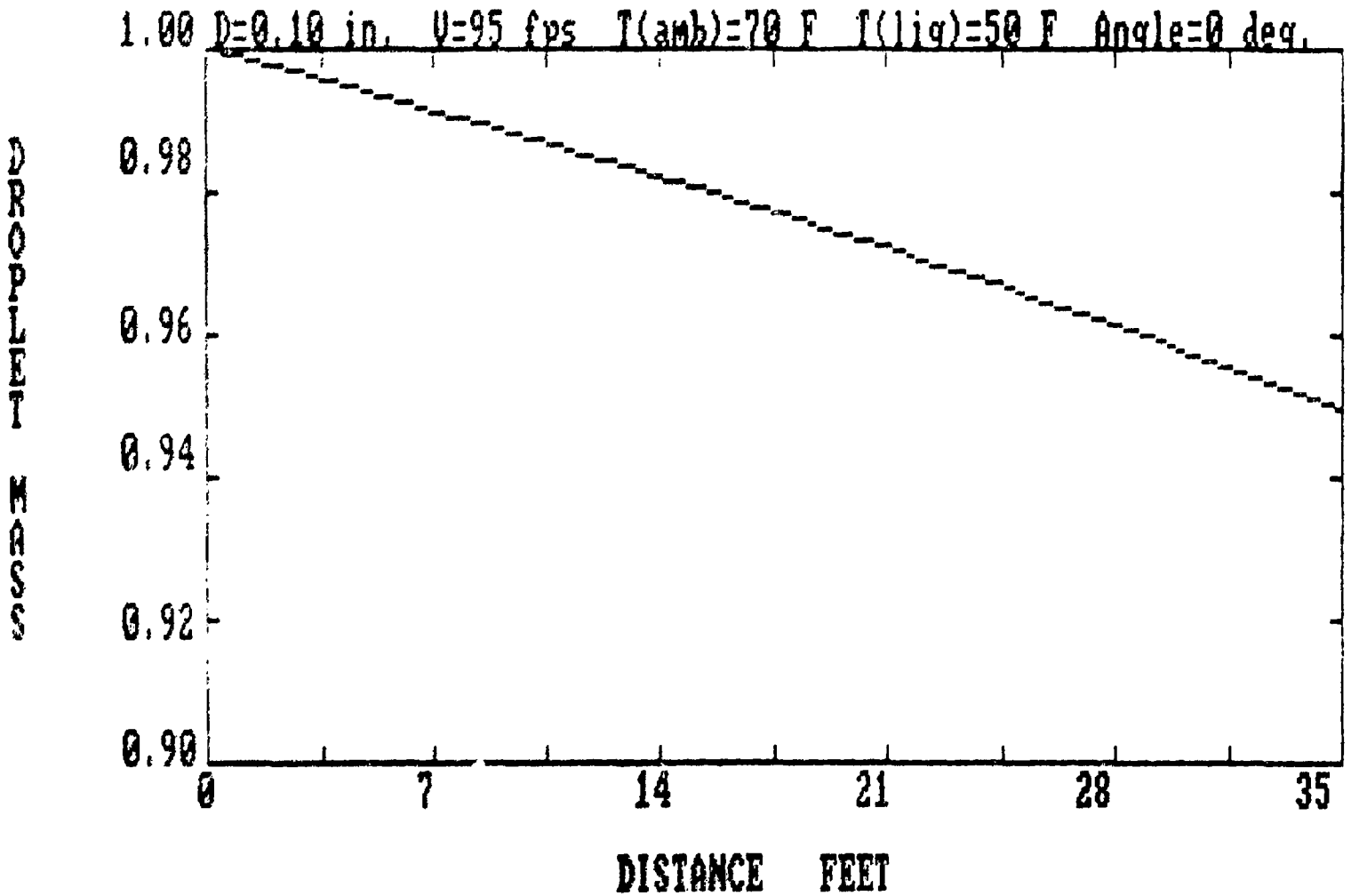

Figure C-44. Calculated Mass Ratio Change for Droplet with Temperature = 50 °F, Drop Diameter = 0.10 Inch, Velocity = 95 ft/s, Nozzle Height = 4 Feet, Ambient Temperature = 70 °F, and Nozzle Angle = 0 Degrees.

APPENDIX D

EXPERIMENTAL EVAPORATION DATA AND GRAPHS

TABLE D-1. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 0 FT/MIN.

Time, Minutes	Mass, grams	Air temp., F	Halon temp., F	Δ Temperature, F
0	215.00	70.6	64.1	-6.5
5	206.96	69.9	58.8	-11.1
10	198.65	69.3	55.6	-13.7
15	192.93	69.2	53.8	-15.4
20	186.67	68.8	52.8	-16.0
25	181.16	68.9	52.4	-16.5
30	176.01	68.9	52.2	-16.7
35	170.15	69.0	52.4	-16.6
40	166.33	69.0	52.5	-16.5
45	161.63	68.8	52.7	-16.1
50	156.92	67.7	52.7	-15.0
55	152.36	67.1	52.6	-14.5
60	147.92	66.9	52.8	-14.1
65	143.44	66.8	52.8	-14.0
70	139.17	66.6	53.0	-13.6
75	134.90	66.7	53.0	-13.7
80	130.87	67.7	53.6	-14.1
85	126.74	67.0	53.7	-13.3
90	122.74	66.8	53.8	-13.0
95	118.71	66.6	53.8	-12.8
100	114.82	66.6	54.0	-12.6
105	111.00	67.4	54.1	-13.3
110	107.30	68.3	54.5	-13.8
116	103.64	68.0	54.6	-13.4
120	99.87	67.7	54.8	-12.9
125	96.29	67.7	55.4	-12.3
130	92.68	67.8	55.3	-12.5
135	89.15	67.8	55.5	-12.3
140	85.59	68.0	55.6	-12.4
146	81.41	68.2	55.8	-12.4
150	78.66	68.3	56.1	-12.2
155	75.23	68.1	56.0	-12.1
160	71.64	68.4	56.4	-12.0
165	68.48	68.5	56.5	-12.0
170	65.16	68.6	56.8	-11.8
175	61.79	69.0	56.6	-12.4
180	58.39	69.0	56.7	-12.3
185	55.12	69.0	56.6	-12.4
190	51.91	69.1	56.6	-12.5
195	48.64	69.0	57.0	-12.0
200	45.47	69.3	57.0	-12.3
205	42.30	69.1	57.0	-12.1

TABLE D-1. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 0 FT/MIN (CONCLUDED).

Time, minutes	Mass, grams	Air temp., F	Halon temp., F	Δ Temperature, F
210	39.13	69.0	56.8	-12.2
215	36.04	68.9	56.8	-12.1
220	32.94	69.0	56.8	-12.2
225	29.89	69.1	56.7	-12.4
230	26.84	69.2	56.6	-12.6
235	23.77	69.2	56.6	-12.6
240	20.73	69.2	61.2	-8.0
245	17.10	69.0	61.3	-7.7
250	14.74	69.0	61.4	-7.6
255	11.72	68.6	61.4	-7.2
260	8.74	68.6	61.4	-7.2
265	5.83	68.3	62.2	-6.1
270	2.97	67.0	62.6	-4.4
275	0.82	67.3	64.2	-3.1
279	0.10	68.0	67.8	-0.2

TABLE D-2. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 50 FT/MIN.

Time, Minutes	Mass, grams	Air temp., F	Halon temp., F	^ Temperature, F
0	215.00	70.6	59.0	-11.6
5	204.27	70.0	53.2	-16.8
10	195.42	70.0	49.9	-20.1
15	186.32	69.3	48.6	-20.7
20	180.15	69.6	48.4	-21.2
25	173.37	70.7	48.5	-22.2
30	166.31	70.4	48.5	-21.9
35	159.86	70.3	49.1	-21.2
40	153.47	70.4	49.4	-21.0
45	146.74	71.2	49.6	-21.6
50	140.99	71.0	50.5	-20.5
55	136.21	69.6	51.1	-18.5
60	130.22	69.2	52.0	-17.2
65	125.05	69.5	52.0	-17.5
70	119.75	69.5	51.9	-17.6
75	114.61	68.5	52.0	-16.5
80	109.46	68.4	51.9	-16.5
85	104.46	68.2	52.2	-16.0
90	99.73	67.8	52.7	-15.1
95	94.99	67.6	52.6	-15.0
100	90.51	67.4	52.4	-15.0
105	86.27	67.4	53.2	-14.2
110	82.06	67.6	53.6	-14.0
115	77.90	67.5	53.7	-13.8
120	73.49	67.3	53.1	-14.8
125	68.66	67.4	52.4	-15.0
130	63.61	67.7	51.8	-15.9
135	58.77	67.6	51.3	-16.3
140	54.05	67.8	51.6	-16.2
145	49.54	67.7	51.8	-15.9
150	45.07	67.8	51.4	-16.4
155	40.49	67.8	51.6	-16.2
160	35.94	67.9	51.5	-16.4
165	31.59	67.9	51.3	-16.6
170	27.38	68.4	51.3	-17.1
175	23.18	68.1	51.3	-16.8
180	19.21	68.8	51.4	-17.4
185	15.21	68.6	51.4	-17.2
190	11.05	68.4	50.6	-17.8
195	6.82	68.3	50.1	-18.2
200	2.83	68.9	59.4	-9.5
205	0.05	67.9	63.4	-4.5

TABLE D-3. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 100 FT/MIN.

Time, Minutes	Mass, grams	Air temp., F	Halon temp., F	^ Temperature, F
0	215.00	64.8	59.5	-5.30
5	199.35	64.7	45.6	-19.1
10	186.46	64.9	39.6	-25.3
15	175.08	64.9	36.5	-28.4
20	164.31	64.8	34.9	-29.9
25	154.04	65.5	34.5	-31.0
30	144.56	66.6	35.0	-31.6
35	134.95	64.8	34.9	-29.9
40	125.68	65.5	35.1	-30.4
45	114.70	65.0	34.6	-30.4
50	107.59	64.8	35.2	-29.6
55	99.25	65.6	35.8	-29.8
60	90.88	66.7	36.0	-30.7
70	75.15	66.3	37.2	-29.1
75	67.20	65.7	38.5	-27.2
80	59.38	65.2	38.7	-26.5
85	51.91	64.8	38.9	-25.9
90	44.78	65.2	39.0	-26.2
95	37.88	64.7	39.0	-25.7
100	31.09	64.4	39.5	-24.9
105	24.43	65.7	39.1	-26.6
110	17.83	65.2	38.7	-26.5
115	11.50	65.7	50.4	-15.3

TABLE D-4. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 200 FT/MIN.

Time, minutes	Mass, grams	Air temp., F	Halon temp., F	^ Temperature, F
0	215.00	71.6	53.9	-17.7
2	204.91	70.0	36.3	-33.7
4	196.28	70.4	33.2	-37.2
6	188.41	70.0	31.0	-39.0
8	180.90	70.0	30.0	-40.0
10	173.67	69.9	29.4	-40.5
12	166.84	69.9	29.2	-40.7
14	160.35	70.5	29.0	-41.5
16	153.82	70.0	28.9	-41.1
18	147.62	70.1	29.0	-41.1
20	141.37	69.9	29.2	-40.7
22	135.06	70.1	29.0	-41.1
24	125.90	70.1	29.2	-40.9
26	122.00	69.9	29.1	-40.8
28	117.09	70.1	29.2	-40.9
30	111.22	70.2	29.3	-40.9
32	106.54	70.8	29.5	-41.3
34	99.77	70.5	29.6	-40.9
36	93.98	71.2	29.5	-41.7
38	88.50	71.2	29.4	-41.8
40	83.12	70.7	29.9	-40.8
42	77.83	69.9	30.1	-39.8
44	72.44	71.1	30.8	-40.3
46	67.24	71.1	30.4	-40.7
48	62.03	71.2	31.2	-40.0
50	57.00	70.2	31.7	-38.5
52	51.61	71.6	31.6	-40.0
54	46.73	70.9	32.2	-38.7
56	41.71	71.5	32.3	-39.2
58	36.72	70.3	33.3	-37.0
60	31.92	70.5	34.8	-35.7
62	26.64	71.3	35.3	-36.0
64	21.81	70.3	36.7	-33.6
66	17.04	71.1	36.9	-34.2
68	12.40	71.1	49.3	-21.8
70	7.88	71.2	49.5	-21.7
72	3.39	70.4	51.0	-19.4
74	0.00	71.2	61.2	-10.0

TABLE D-5. HALON 2402 EVAPORATION DATA, AIR VELOCITY = 300 FT/MIN.

Time, minutes	Mass, grams	Air temp., F	Halon temp., F	^ Temperature, F
0	215.0	78.0	63.7	-14.3
2	195.2	77.8	49.4	-28.4
4	181.7	77.6	40.8	-36.8
6	170.8	77.9	35.9	-42.0
8	160.7	77.8	33.2	-44.6
10	151.6	77.7	32.2	-45.5
12	142.9	77.9	31.1	-46.8
14	134.6	77.5	30.7	-46.8
16	126.3	78.1	30.3	-47.8
18	118.2	78.1	29.9	-48.2
20	110.1	77.6	29.5	-48.1
22	101.5	78.1	29.6	-48.5
24	94.5	78.0	30.0	-48.0
26	86.6	78.2	29.6	-48.6
28	79.1	78.2	29.7	-48.5
30	71.4	78.4	29.5	-48.9
32	63.9	78.3	29.4	-48.9
34	56.7	78.0	29.6	-48.4
36	49.9	78.1	30.0	-48.1
38	42.5	78.1	31.0	-47.1
40	35.5	78.4	32.1	-46.3
42	28.3	78.7	34.2	-44.5
44	21.4	78.4	35.9	-42.5
46	15.0	79.1	35.0	-44.1
48	8.3	79.1	29.2	-49.9
50	1.6	78.6	61.0	-17.6
51	0.0	78.5	66.9	-11.6

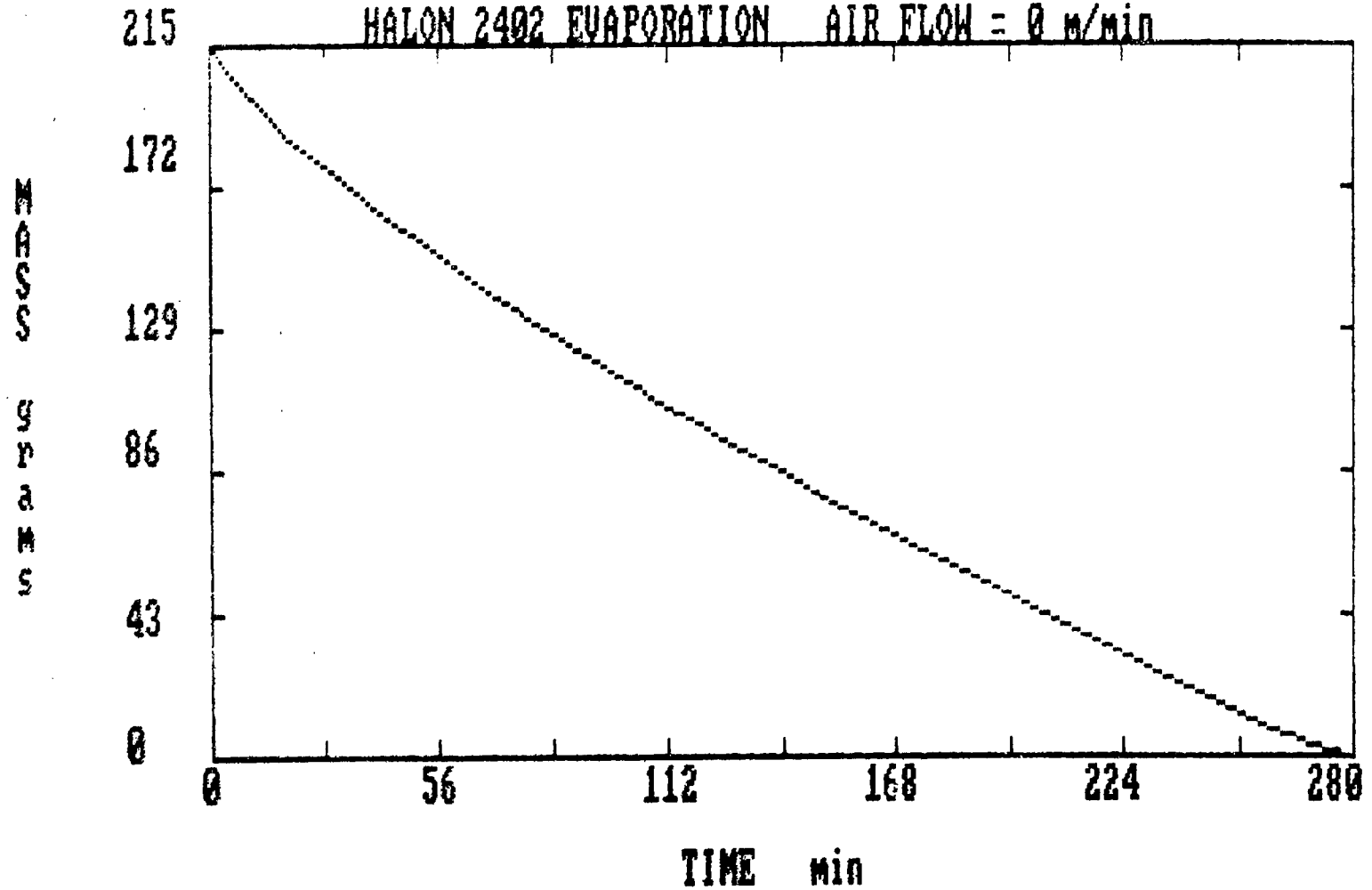

Figure D-1. Halon 2402 Mass as a Function of Time for Air Velocity = 0 Meters per Minute.

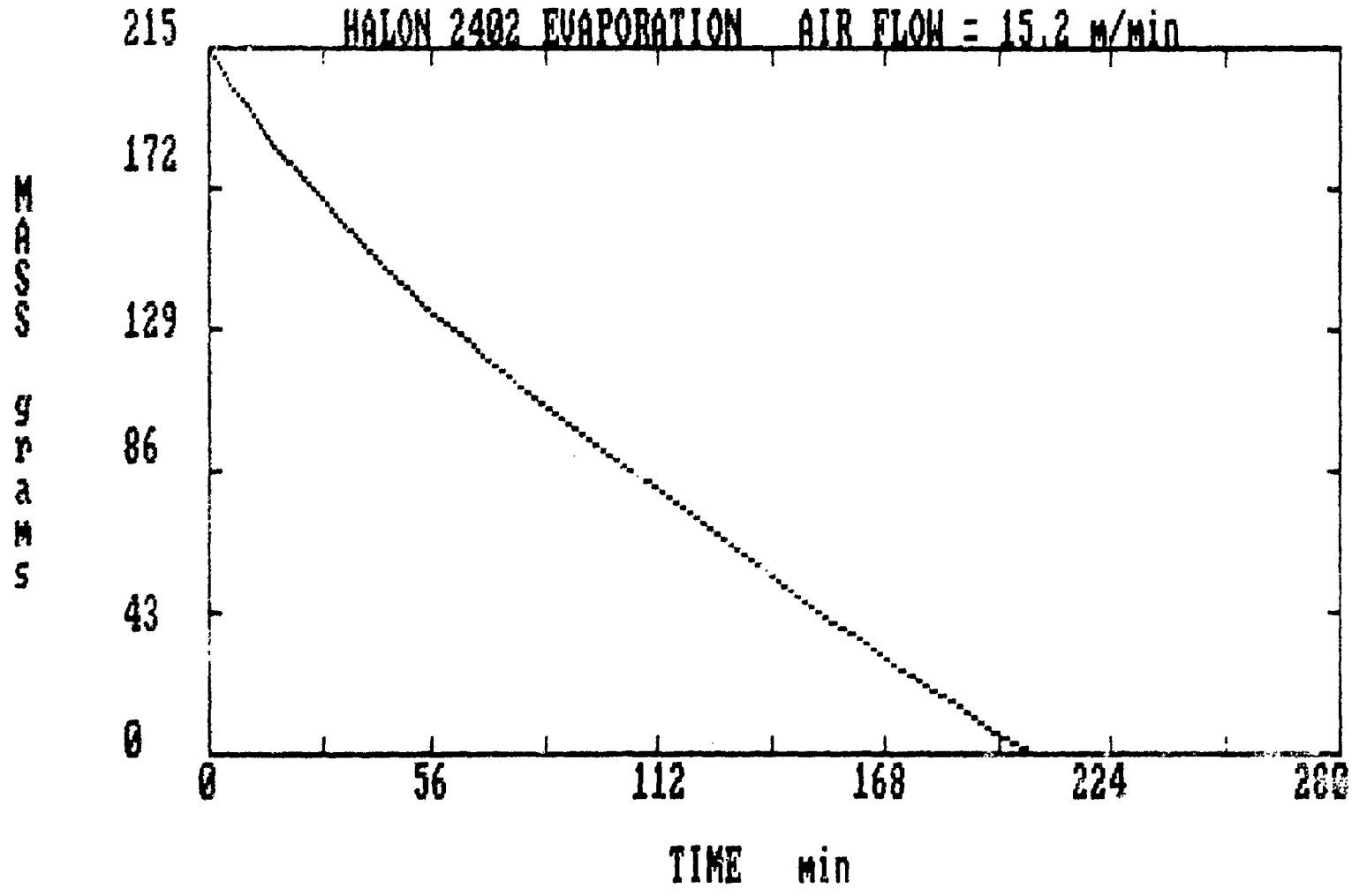

Figure D-2. Halon 2402 Mass as a Function of Time for Air Velocity = 15.2 Meters per Minute.

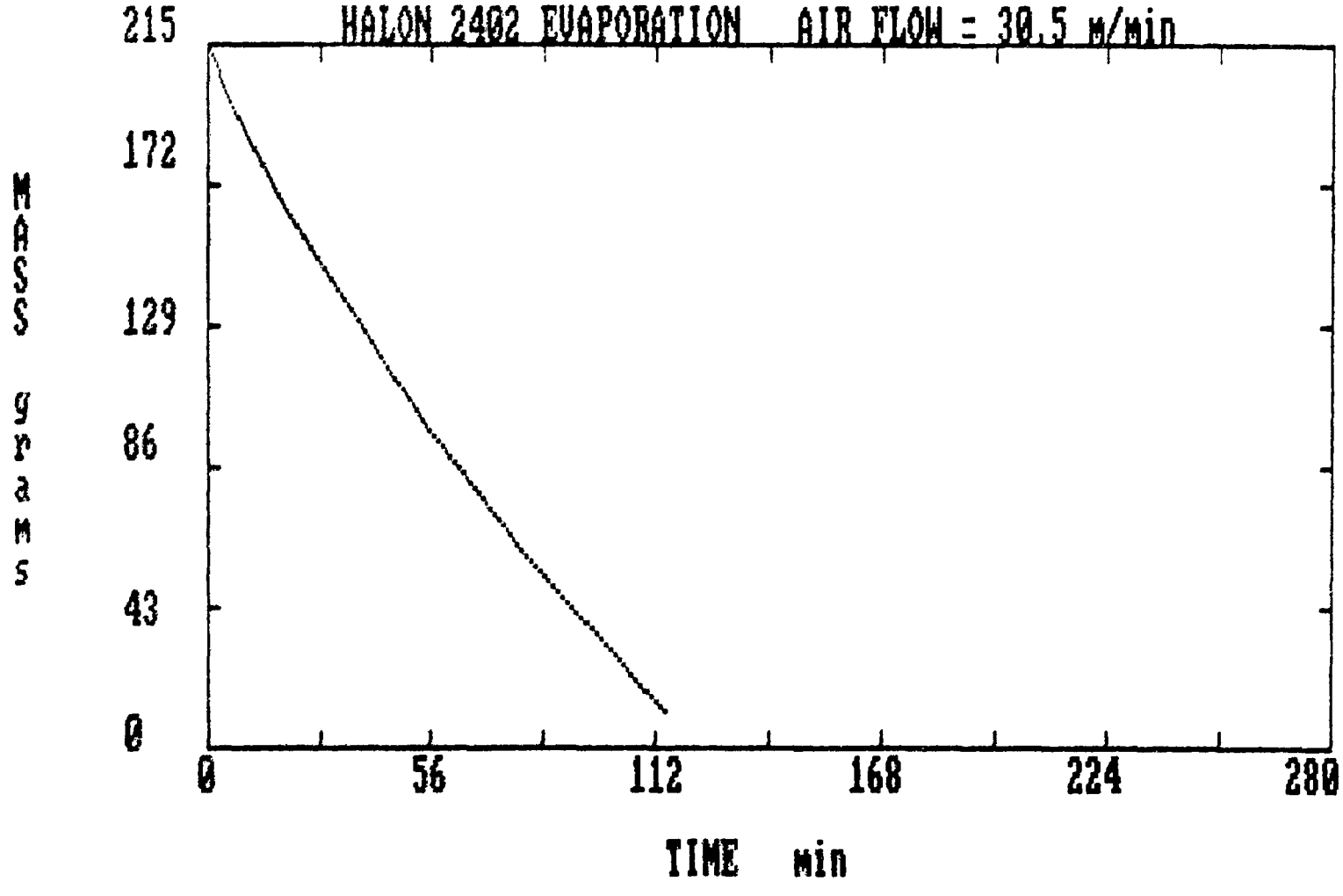

Figure D-3. Halon 2402 Mass as a Function of Time for Air Velocity = 30.5 Meters per Minute.

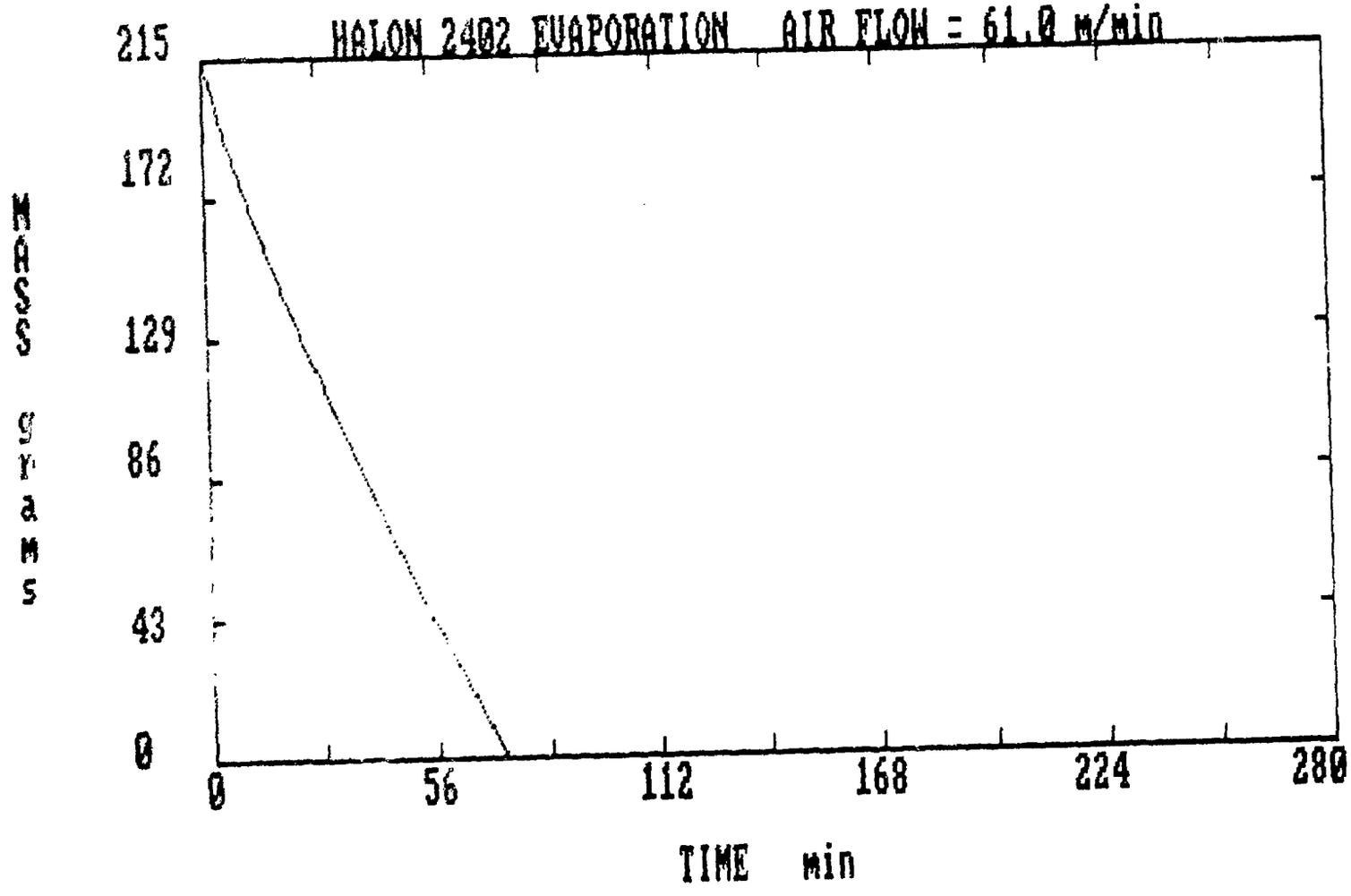

Figure D-4. Halon 2402 Mass as a Function of Time for Air Velocity = 61.0 Meters per Minute.

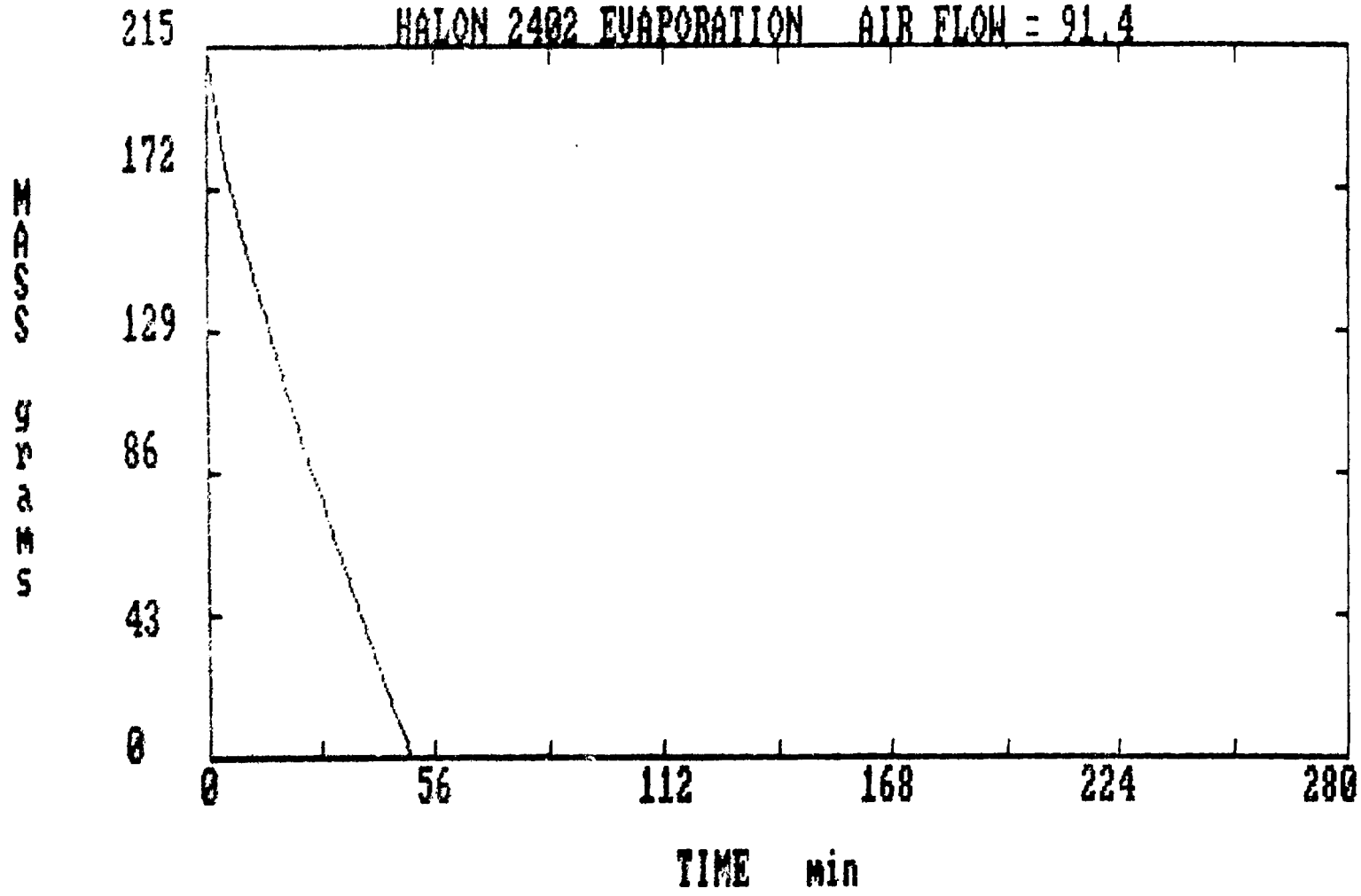

Figure D-5. Halon 2402 Mass as a Function of Time for Air Velocity = 91.4 Meters per Minute.

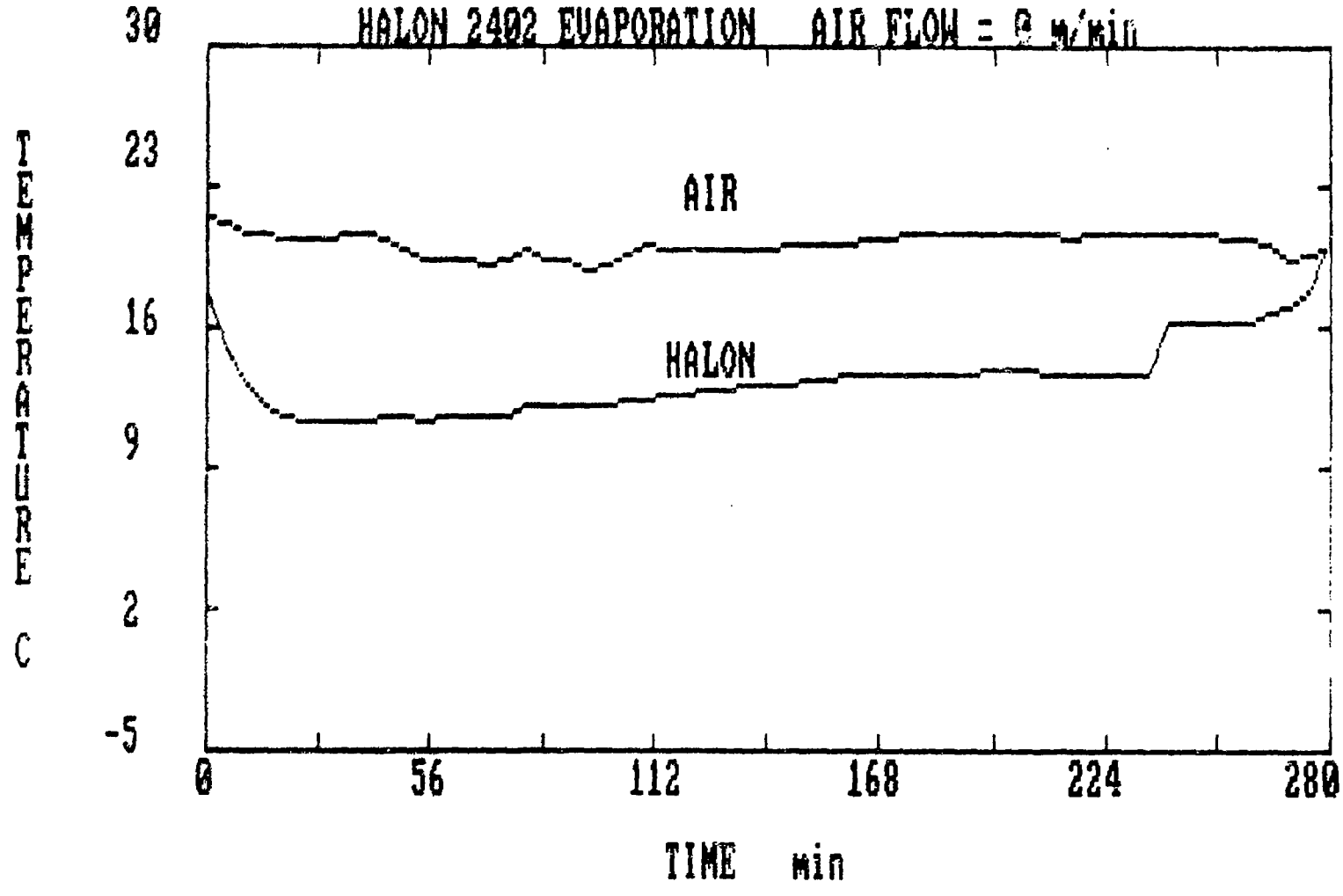

Figure D-6. Ambient and Halon 2402 Temperatures as Functions of Time for Air Velocity = 0 Meters per Minute.

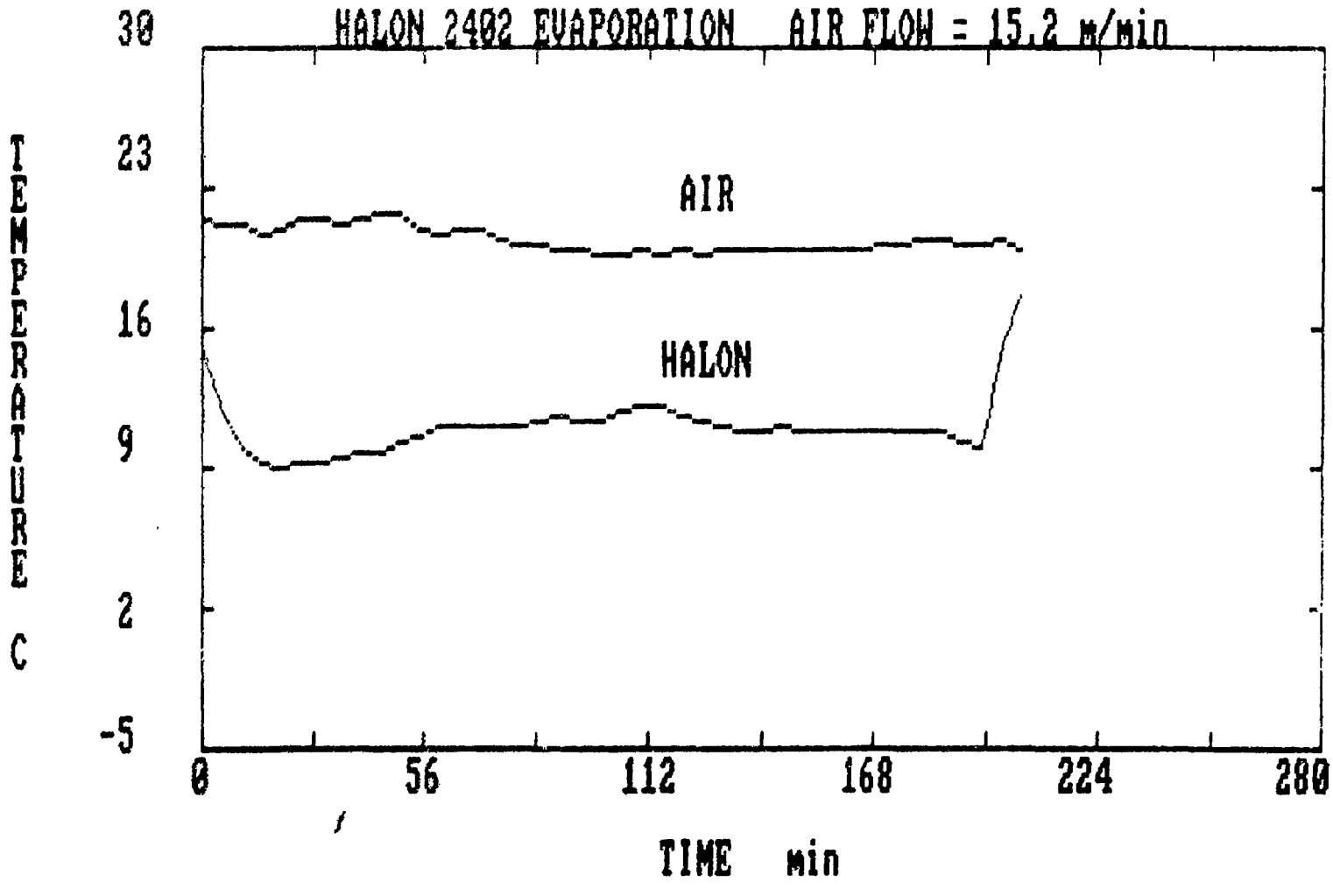

Figure D-7. Ambient and Halon 2402 Temperatures as Functions of Time for Air Velocity = 15.2 Meters per Minute.

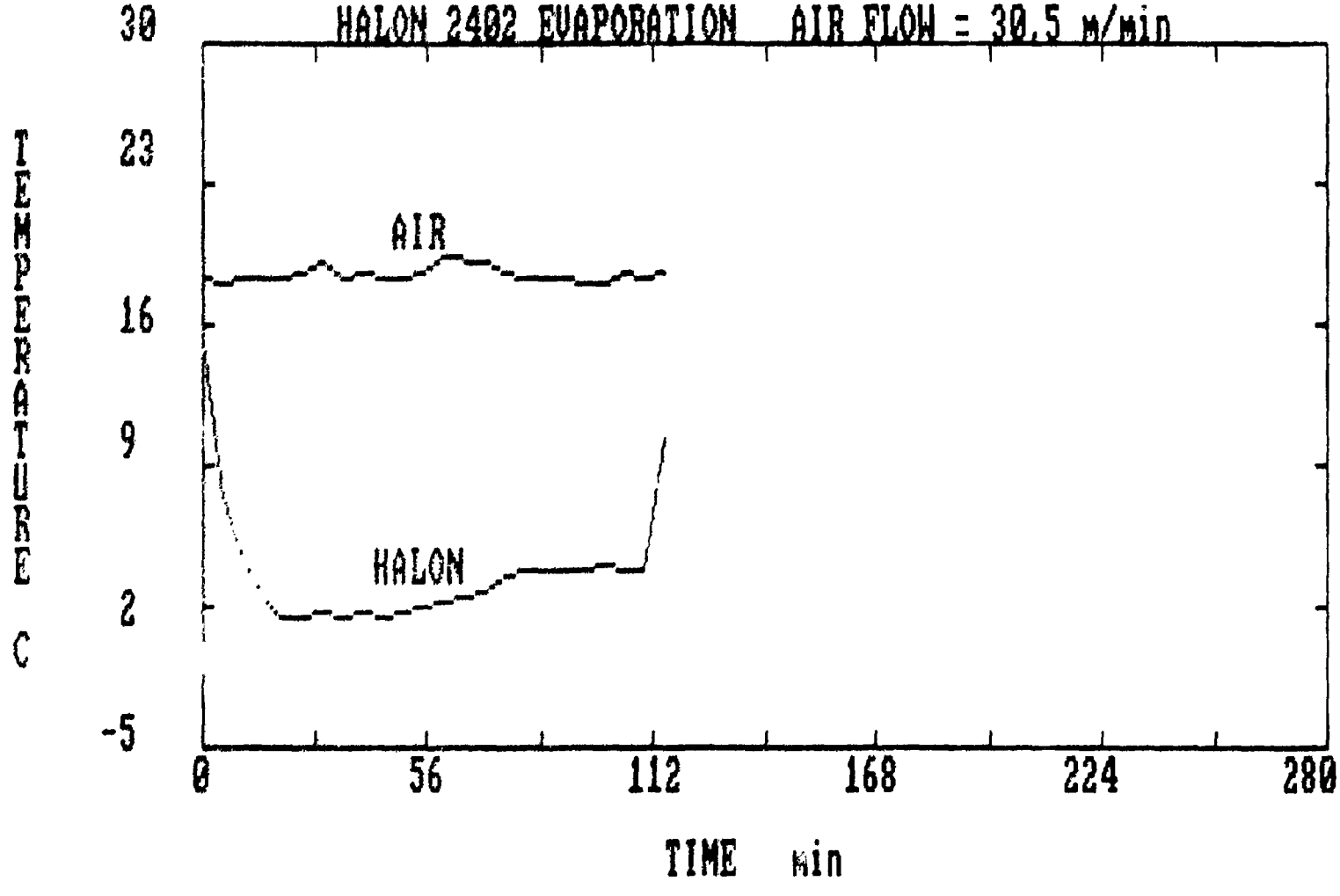

Figure D-8. Ambient and Halon 2402 Temperatures as Functions of Time for Air Velocity = 30.5 Meters per Minute.

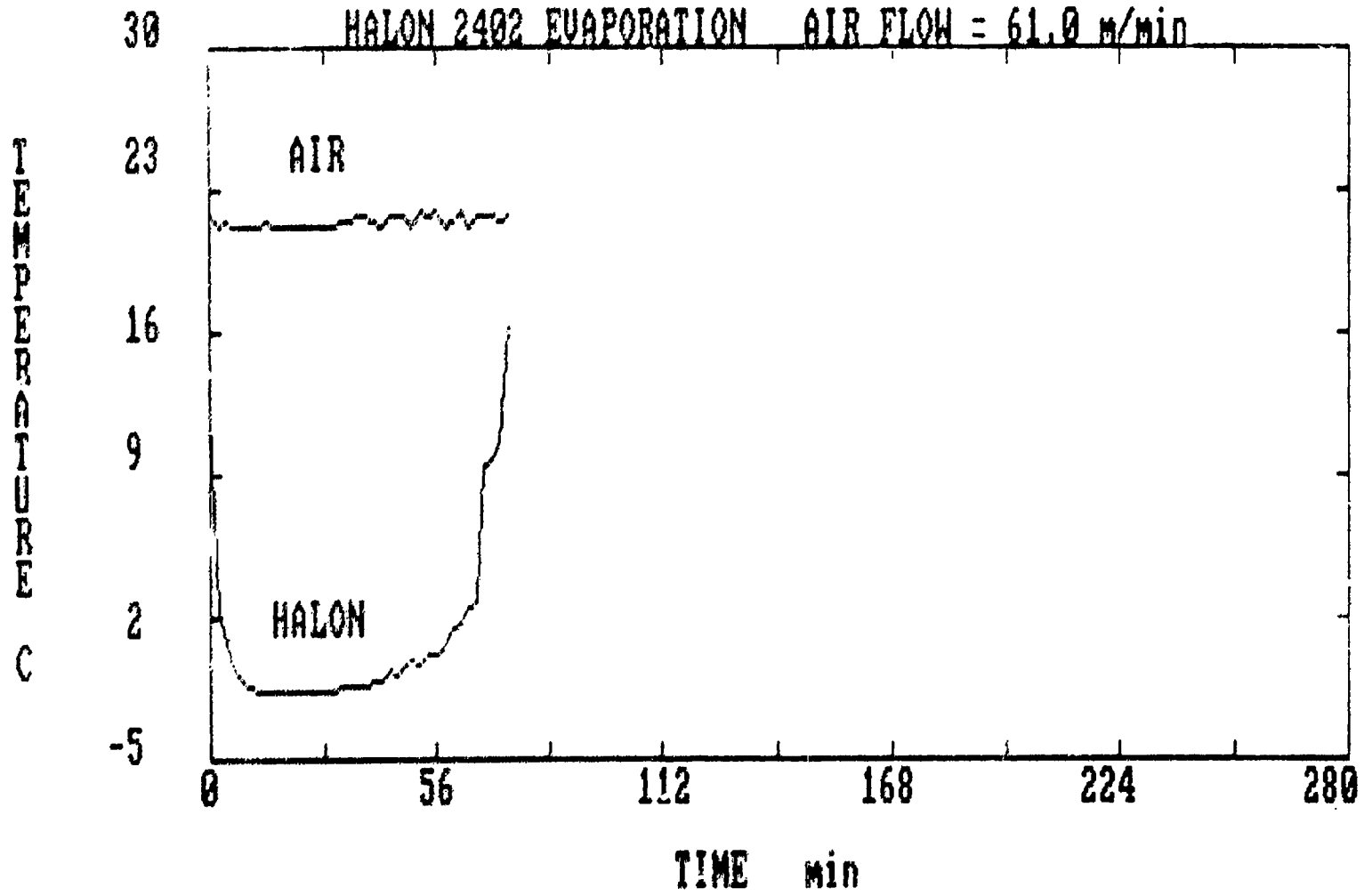

Figure D-9. Ambient and Halon 2402 Temperatures as Functions of Time for Air Velocity = 61.0 Meters per Minute.

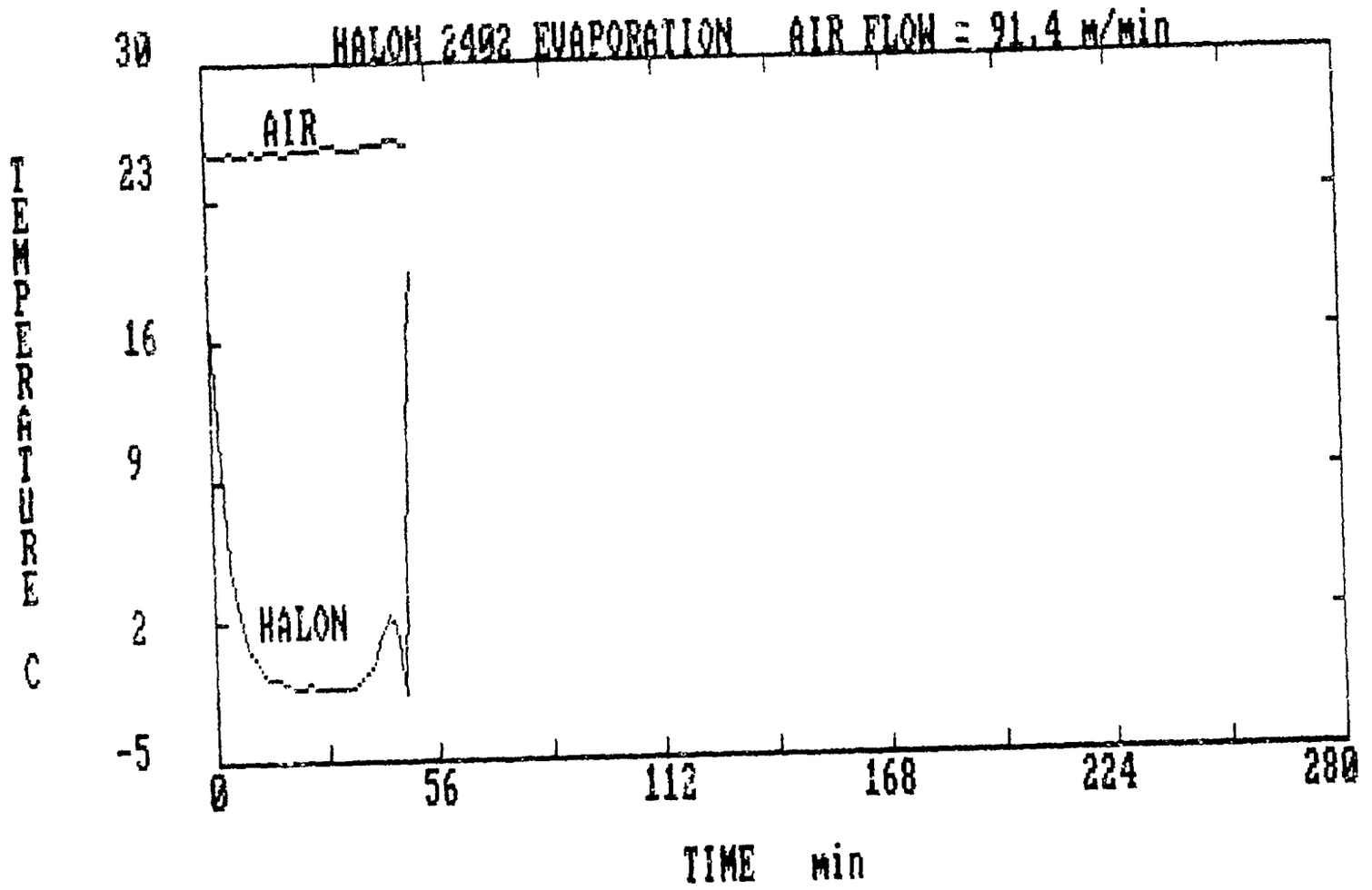

Figure D-10. Ambient and Halon 2402 Temperatures as Functions of Time for Air Velocity = 91.4 Meters per Minute.

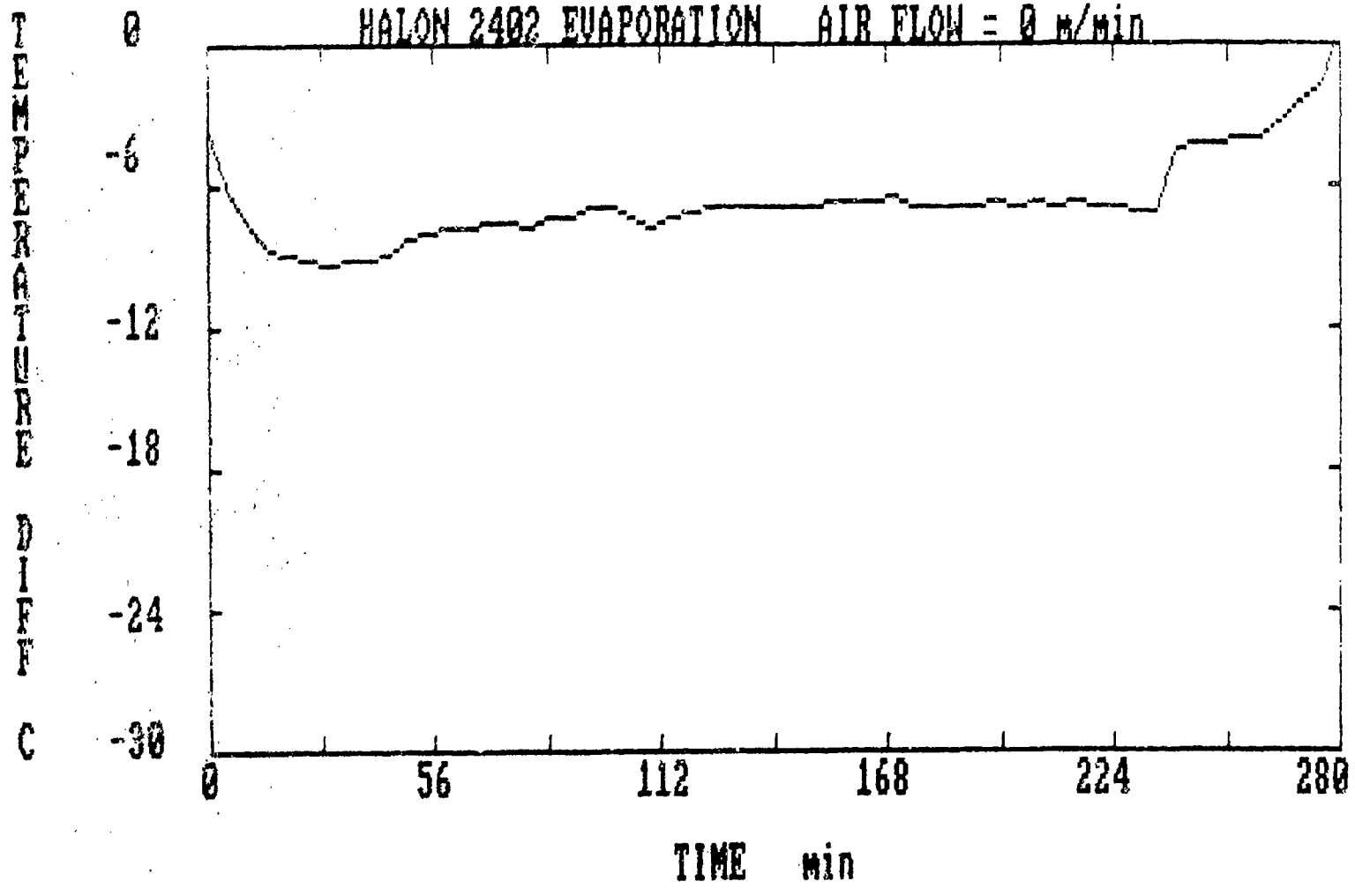

Figure D-11. Temperature Difference Between Air and Evaporating Halon 2402 as a Function of Time. Air Velocity = 0 Meters per Minute.

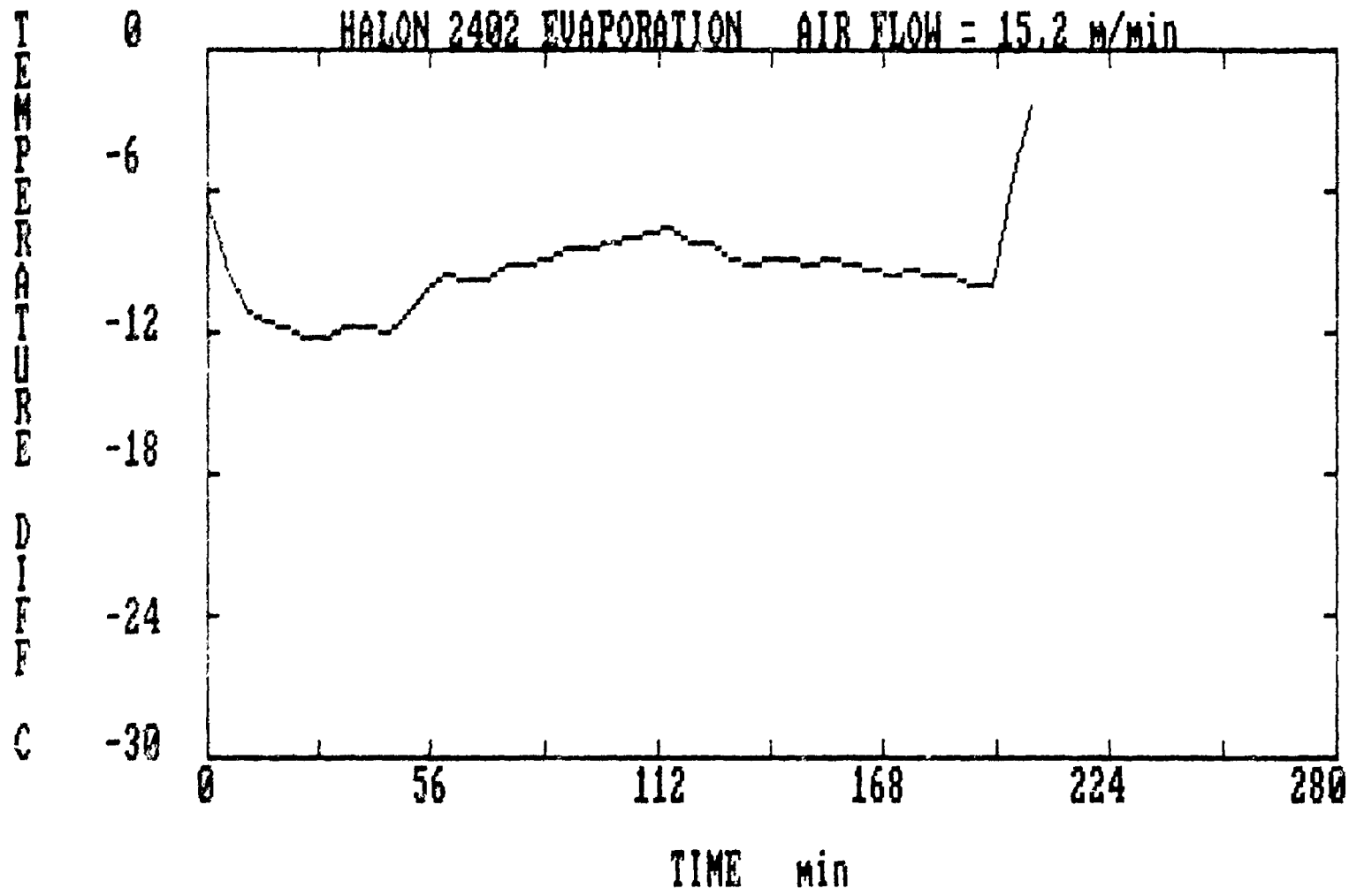

Figure D-12. Temperature Difference Between Air and Evaporating Halon 2402 as a Function of Time. Air Velocity = 15.2 Meters per Minute.

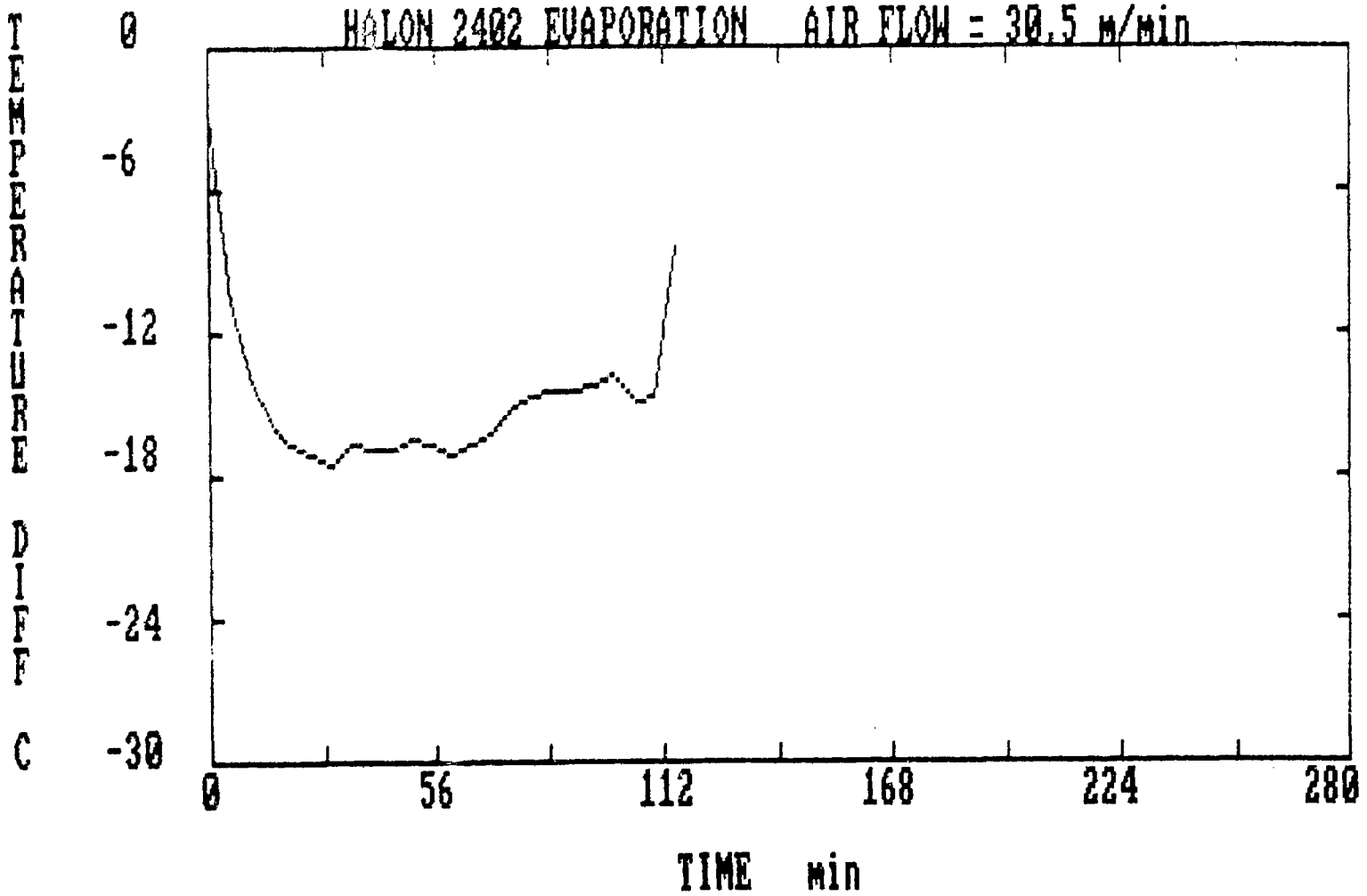

Figure D-13. Temperature Difference Between Air and Evaporating Halon 2402 as a Function of Time. Air Velocity = 30.5 Meters per Minute.

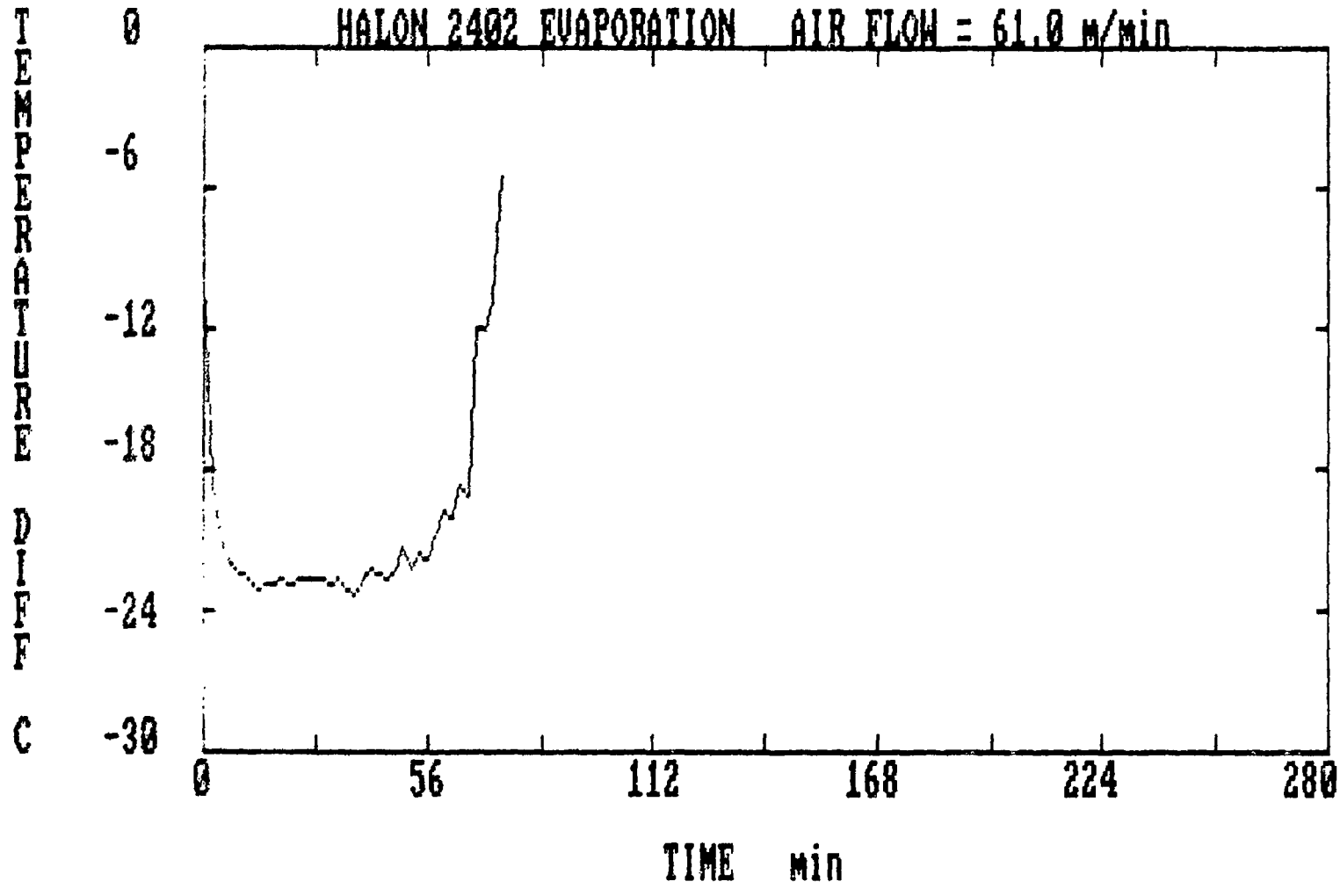

Figure D-14. Temperature Difference Between Air and Evaporating Halon 2402 as a Function of Time. Air Velocity = 61.0 Meters per Minute.

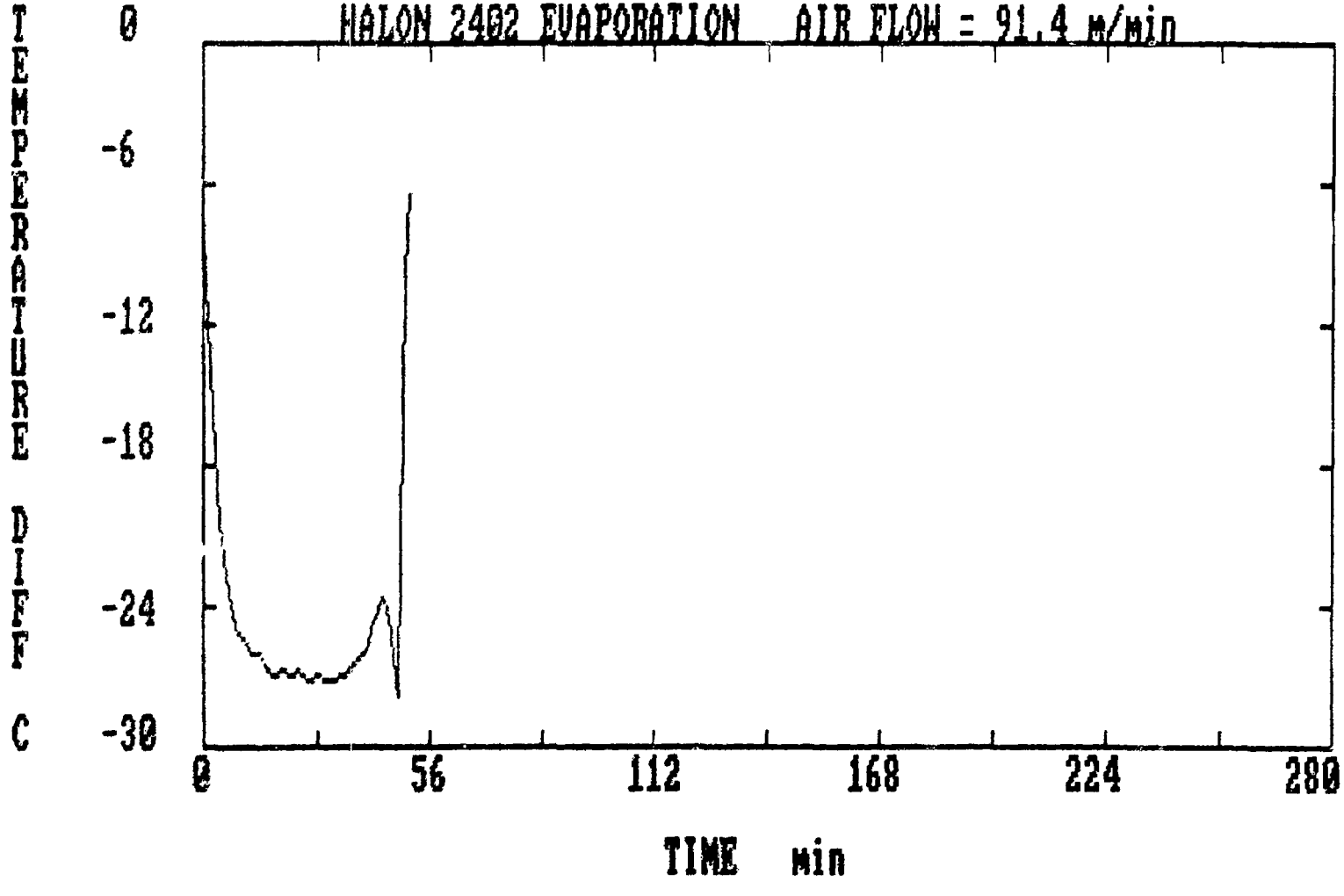

Figure D-15. Temperature Difference Between Air and Evaporating Halon 2402 as a Function of Time. Air Velocity = 91.4 Meters per Minute.

APPENDIX E

CHROMATOGRAPHIC DATA FOR ENCLOSED JP-4 FIRE EMISSION TESTS

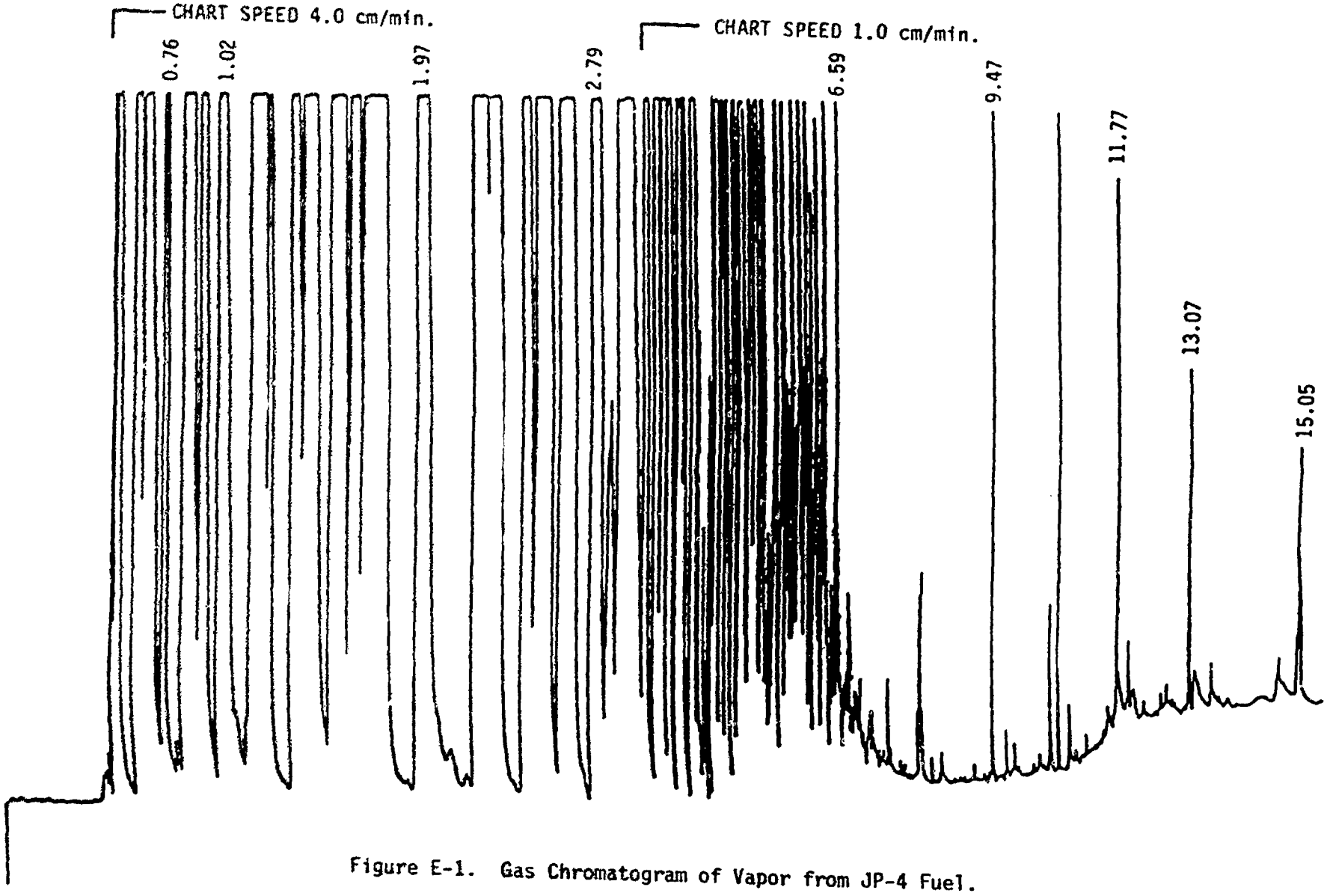

Figure E-1. Gas Chromatogram of Vapor from JP-4 Fuel.

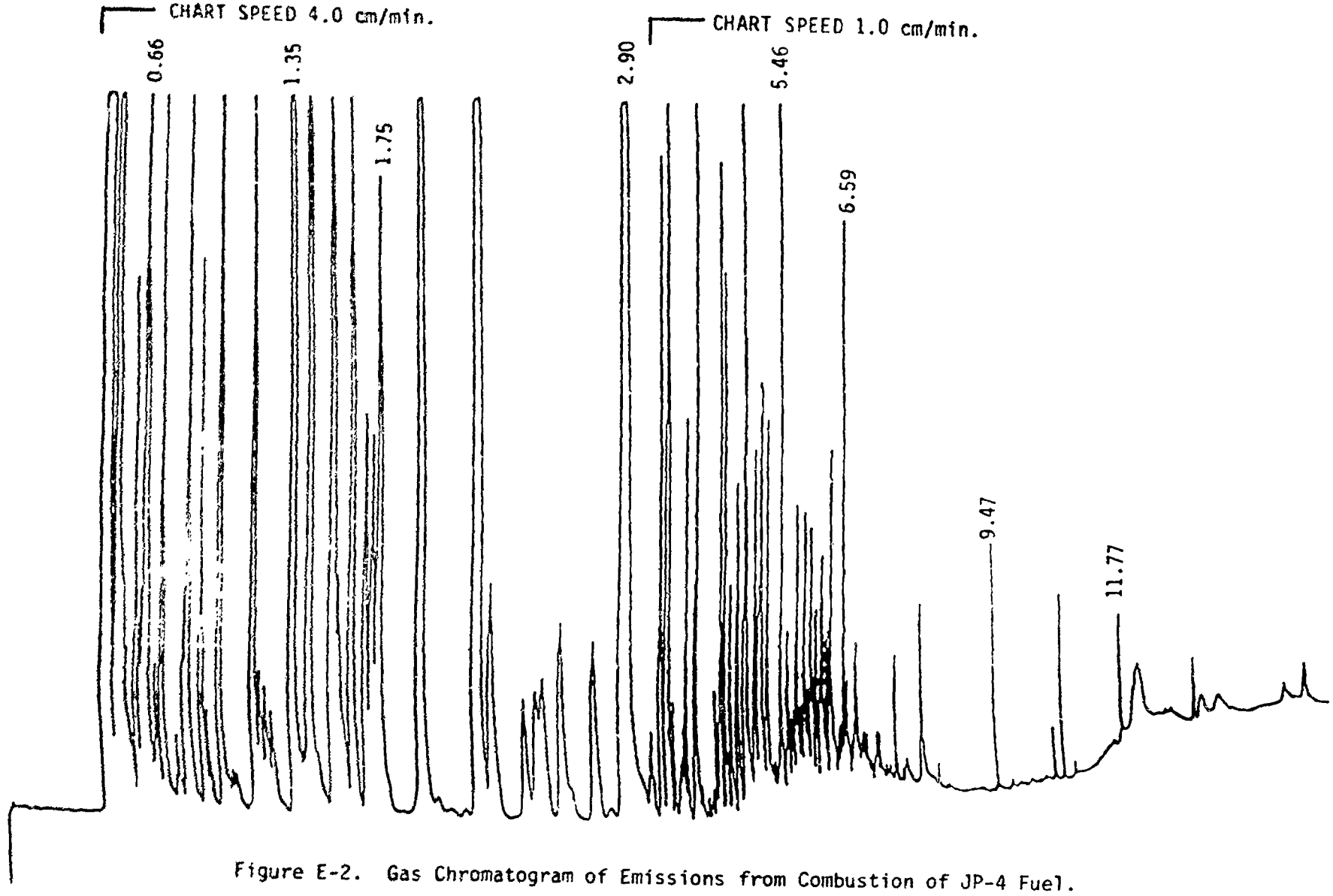

Figure E-2. Gas Chromatogram of Emissions from Combustion of JP-4 Fuel.

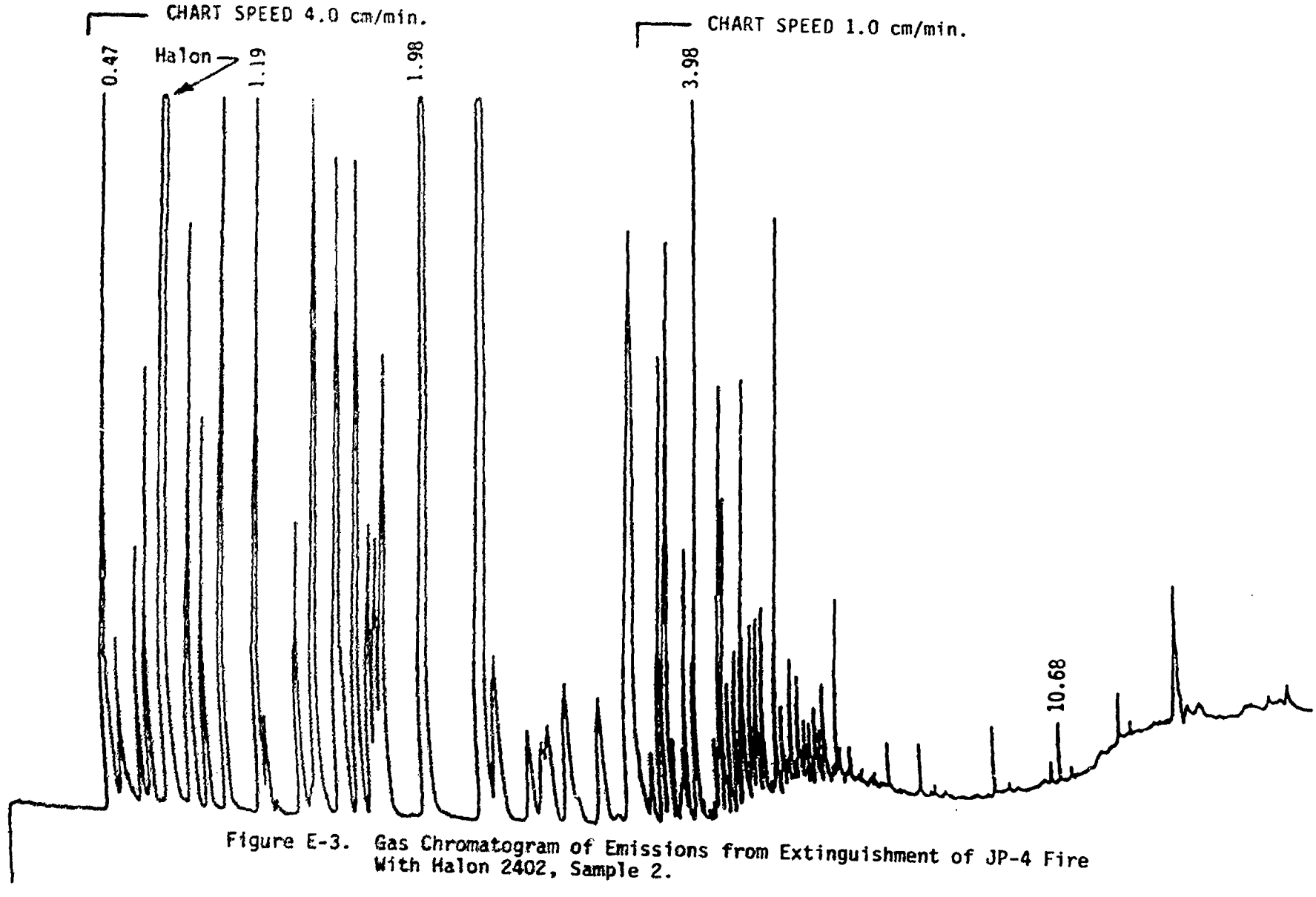

Figure E-3. Gas Chromatogram of Emissions from Extinguishment of JP-4 Fire With Halon 2402, Sample 2.

TABLE E-1. RETENTION TIMES AND GC PEAK AREA PERCENTAGES FOR ENCLOSED FIRE TESTS, FUMES FROM JP-4 FUEL.

Retention time, min	Area, %	Retention time, min	Area, %	Retention time, min	Area, %
0.49	0.001	3.55	0.226	5.78	0.019
0.51	0.026	3.66	0.098	5.81	0.011
0.53	0.292	3.71	0.271	5.84	0.029
0.62	6.713	3.78	0.643	5.89	0.088
0.67	8.598	3.92	0.374	5.91	0.030
0.71	0.021	3.97	1.797	5.96	0.043
0.76	0.380	4.06	0.050	6.01	0.081
0.81	0.001	4.16	0.019	6.05	0.024
0.85	1.963	4.23	0.036	6.10	0.071
0.87	5.877	4.31	0.134	6.20	0.050
0.93	3.543	4.37	0.108	6.23	0.031
1.02	7.753	4.40	0.725	6.26	0.015
1.18	5.942	4.48	0.535	6.29	0.025
1.22	0.629	4.52	0.054	6.36	0.075
1.26	0.087	4.57	0.251	6.40	0.019
1.37	1.466	4.63	0.014	6.43	0.008
1.42	0.142	4.69	0.217	6.51	0.014
1.45	5.473	4.71	0.232	6.55	0.012
1.56	3.974	4.78	0.008	6.59	0.067
1.59	0.916	4.82	0.901	6.64	0.015
1.65	3.164	4.87	0.209	6.67	0.016
1.71	1.451	4.90	0.028	6.75	0.004

TABLE E-1. RETENTION TIMES AND GC PEAK AREA PERCENTAGES FOR ENCLOSED FIRE TESTS, FUMES FROM JP-4 FUEL (CONCLUDED).

Retention time, min	Area, %	Retention time, min	Area, %	Retention time, min	Area, %
1.74	1.339	4.95	0.017	6.79	0.003
1.77	2.438	5.01	0.280	6.83	0.003
1.97	5.925	5.03	0.033	6.87	0.008
2.24	9.950	5.10	0.204	6.91	0.001
2.30	0.833	5.12	0.263	6.99	0.002
2.45	0.384	5.22	0.211	7.05	0.003
2.52	0.305	5.25	0.068	7.54	0.005
2.55	0.397	5.29	0.005	8.07	0.018
2.63	0.589	5.32	0.008	8.12	0.013
2.68	0.079	5.36	0.012	9.47	0.050
2.79	0.520	5.40	0.010	9.74	0.003
2.86	0.035	5.46	0.516	10.53	0.009
2.92	3.314	5.58	0.101	10.69	0.042
3.10	0.162	5.62	0.036	10.90	0.003
3.15	0.266	5.66	0.027	11.77	0.037
3.30	1.968	5.70	0.029	11.99	0.004
3.42	1.409	5.72	0.013	13.07	0.034
3.46	1.795	5.75	0.100	15.05	0.035

TABLE E-2. RETENTION TIMES AND GC PEAK AREA PERCENTAGES FOR ENCLOSED FIRE TESTS, EMISSIONS FROM JP-4 COMBUSTION.

Retention time, min	Area, %	Retention time, min	Area, %	Retention time, min	Area, %
0.46	22.902	2.21	6.529	5.66	0.056
0.48	5.613	2.28	0.585	5.69	0.059
0.53	4.324	2.43	0.227	5.75	0.429
0.56	0.246	2.49	0.111	5.78	0.064
0.59	0.022	2.52	0.141	5.83	0.058
0.62	0.500	2.61	0.417	5.88	0.362
0.64	0.197	2.76	0.440	5.96	0.063
0.66	1.367	3.44	2.150	6.00	0.548
0.70	0.042	3.54	0.249	6.05	0.132
0.72	0.159	3.65	0.052	6.09	0.523
0.74	0.854	3.70	0.093	6.19	0.421
0.80	0.085	3.77	0.821	6.22	0.242
0.85	0.260	3.91	0.500	6.25	0.059
0.87	0.961	3.96	2.975	6.29	0.180
0.93	0.619	4.30	0.213	6.36	0.730
0.95	0.112	4.36	0.108	6.40	0.140
1.01	1.688	4.39	1.290	6.55	0.053
1.06	0.015	4.47	1.027	6.59	0.821
1.08	0.019	4.57	0.500	6.63	0.077

TABLE E-2. RETENTION TIMES AND GC PEAK AREA PERCENTAGES FOR ENCLOSED FIRE TESTS, EMISSIONS FROM JP-4 COMBUSTION (CONCLUDED).

Retention time, min	Area, %	Retention time, min	Area, %	Retention time, min	Area, %
1.17	1.588	4.68	0.645	6.67	0.111
1.20	0.187	4.71	0.583	6.80	0.179
1.23	0.181	4.81	2.306	6.83	0.192
1.26	0.132	4.86	0.513	6.86	0.121
1.35	3.448	5.00	0.769	7.05	0.031
1.43	1.768	5.09	0.882	7.28	0.038
1.53	1.676	5.12	0.808	7.54	0.184
1.57	0.486	5.22	0.717	8.12	0.213
1.63	1.427	5.24	0.219	9.47	0.361
1.69	0.642	5.46	2.154	10.53	0.070
1.72	0.605	5.58	0.357	10.68	0.291
1.75	1.096	5.61	0.124	11.77	0.227
1.94	3.543				

TABLE E-3. RETENTION TIMES AND GC PEAK AREA PERCENTAGES FOR ENCLOSED FIRE TESTS, SAMPLE 2.

Retention time, min	Area, %	Retention time, min	Area, %	Retention time, min	Area, %
0.47	0.787	2.31	0.371	5.01	0.392
0.49	0.176	2.46	0.178	5.10	0.249
0.53	0.177	2.53	0.064	5.13	0.317
0.62	0.252	2.56	0.114	5.22	0.367
0.67	0.446	2.64	0.291	5.25	0.106
0.75	62.772	2.80	0.296	5.46	0.982
0.86	0.187	2.94	1.673	5.58	0.082
0.88	0.681	3.31	1.560	5.62	0.040
0.94	0.461	3.43	1.185	5.75	0.176
1.03	1.276	3.46	1.532	5.89	0.161
1.19	1.180	3.56	0.150	6.01	0.067
1.22	0.139	3.72	0.049	6.20	0.099
1.38	0.454	3.79	0.570	6.22	0.048
1.45	1.383	3.93	0.331	6.29	0.061
1.56	1.327	3.98	1.901	6.36	0.174
1.59	0.274	4.31	0.137	6.40	0.029
1.66	1.119	4.40	0.732	6.59	0.272
1.72	0.501	4.48	0.593	6.83	0.038
1.75	0.479	4.58	0.295	7.54	0.059
1.78	0.865	4.72	0.105	8.12	0.054
1.98	2.706	4.82	1.007	9.47	0.100
2.24	4.928	4.87	0.274	10.68	0.072
				11.77	0.081

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APPENDIX F

CALIBRATION PROCEDURES FOR ENCLOSED JP-4 FIRE EMISSION TESTS

Halon 2402 calibration curves were prepared using both gaseous and liquid halon. The gaseous standards were prepared by filling five 14.06 mL test tubes with varying amounts of liquid Halon 2402 using a 1 uL syringe with an estimated precision of 0.005 mL. An additional 5.00 uL of air was added to pressurize the test tube. The total volume would then be 19.06 uL were the pressure kept constant at ambient (632 Torr). From the known density of Halon 2402 (2.16 g/mL at 25 °C), the gas volume (19.06 mL), and the volumes of liquid Halon 2402, the concentrations in ppm by volume (calculated as moles of Halon 2402/moles of air) were determined. A 500 uL gas-tight syringe accurate to ±0.5 uL was used to deliver 200 uL samples to the gas chromatograph with a reproducibility of better than 2 percent. Only one aliquot was taken from each tube. The integrated peak areas (1/8 μV-s) were determined from the HP3392A integrator. The results are shown in Table F-1.

TABLE F-1. PEAK AREA AS A FUNCTION OF GASEOUS HALON 2402 INJECTION MASS.

Test tube number	Volume of liquid, uL	Mass of halon in test tube, mg	Mass of halon delivered to GC, μg	Peak area, AU
1	0.200	0.432	4.533	79.20
2	0.400	0.864	9.066	149.90
3	0.600	1.296	13.599	247.06
4	0.800	1.728	18.132	313.22
5	1.000	2.160	22.665	420.99

The data in Table F-1 can be fit to a least-squares straight line forced to go through the origin (Figure F-1). The derivation of such a line follows. Consider a line described with the function $y = Bx$. For a set of data points y_i, x_i, the residual for any point is

$$r_i = y_i - Bx_i \tag{F-1}$$

The square of the residual is

$$r_i^2 = (y_i - Bx_i)^2 = y_i^2 - 2Bx_iy_i + B^2x_i^2 \tag{F-2}$$

Let R be the sum of the squares of the residuals,

$$R = \Sigma r_i^2 = \Sigma y_i^2 - 2B\Sigma x_iy_i + B^2\Sigma x_i^2 \tag{F-3}$$

Taking the derivative with respect to B, one obtains

$$dR/dB = 0 - 2\Sigma x_iy_i + 2B\Sigma x_i^2 = 0 \tag{F-4}$$

A solution of this equation gives

$$B = \Sigma x_iy_i/\Sigma x_i^2 \tag{F-5}$$

Application of this equation to the data in Table F-1 gives

$$\text{Peak Area (AU)} = 17.96125 \text{ mass } (\mu g) \tag{F-6}$$

Liquid-sample calibrations were performed with direct injections of liquid Halon 2402 into the gas chromatograph using a 1 uL syringe accurate to ±0.001 uL. Peak areas (Table F-2) were plotted as a function of micrograms of Halon 2402 and fitted by least-squares to give a straight line through the origin (Figure F-2) with equation

$$\text{Peak Area (AU)} = 32.58 \text{ mass } (\mu g) \tag{F-7}$$

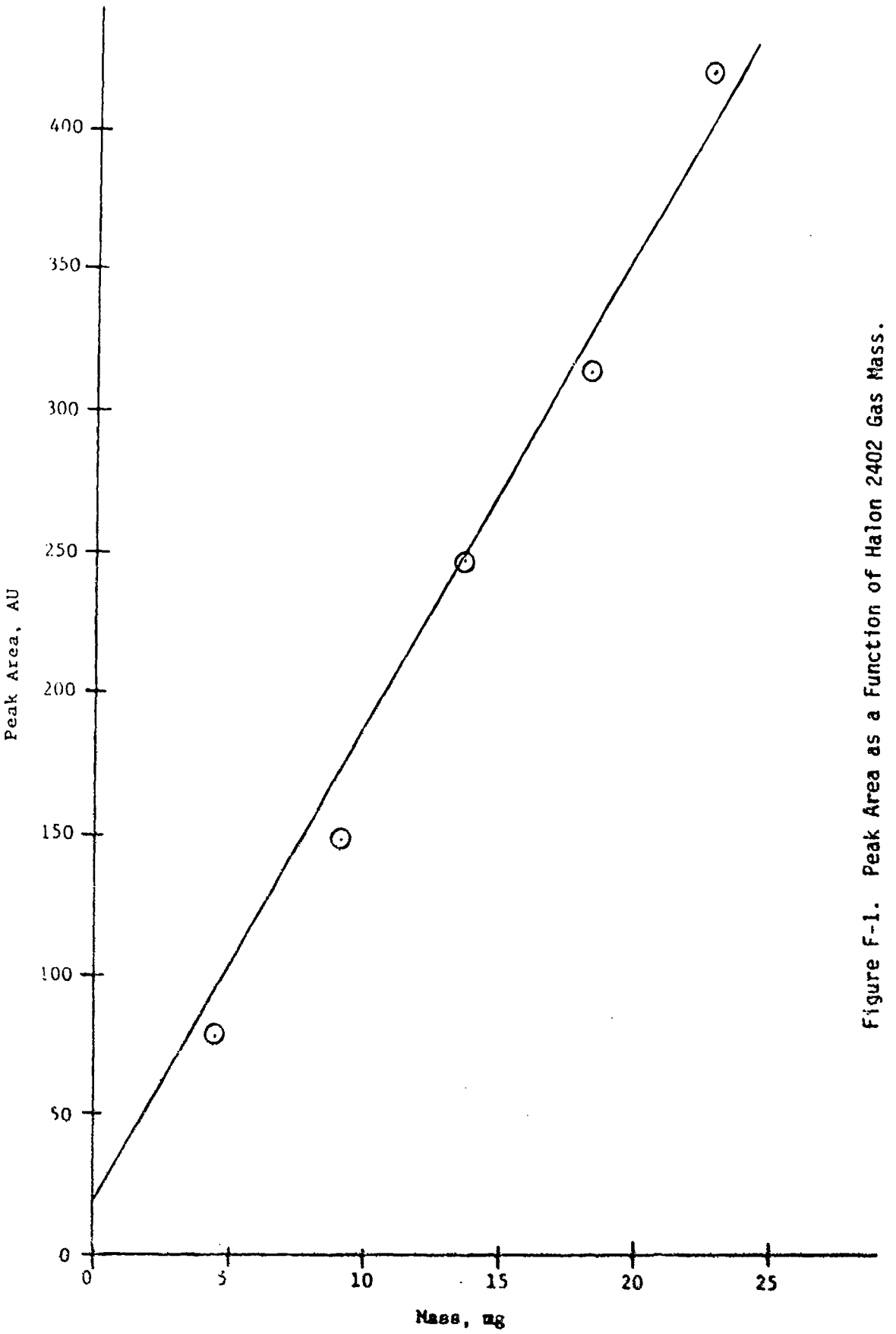

Figure F-1. Peak Area as a Function of Halon 2402 Gas Mass.

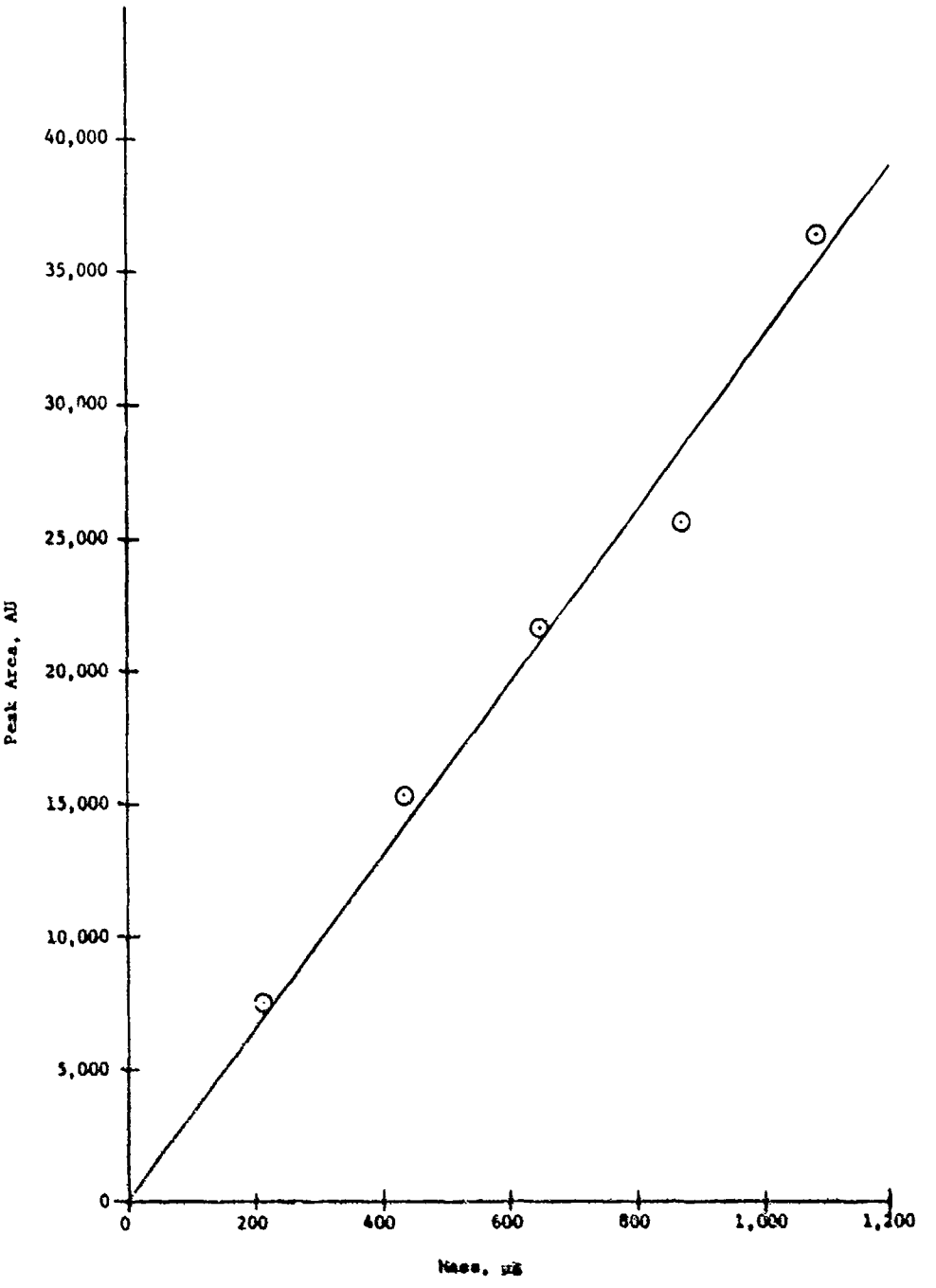

Figure F-2. GC Peak Area as a Function of Halon 2402 Mass.

TABLE F-2. GC PEAK AREA AS A FUNCTION OF HALON 2402 MASS.

Liquid volume, µl	Sample mass, µg	Peak area 1/8 µV-s
0.050	108	4619.22
0.100	216	7512.75
0.200	432	15316.80
0.300	648	21690.50
0.400	864	29596.40
0.500	1080	36295.40

Analyses of the data from the liquid and gas calibrations show that the integration area per microgram for the liquid injection is approximately twice that for the gas injection. There are several possible reasons for this. The FID response may be nonlinear (the liquid sample injection amounts are much larger than the gas sample injections); material may have been lost during the multistep preparation of the gaseous standards; the injection of liquid into the heated GC injection port may have permitted better delivery than injection into the room-temperature test tubes; the sample splitter may discriminate against halon from a gas injection. Since gaseous sample delivery from the test tube preparations best models the delivery from grab sample bottles, results from the gas samples (Table F-1) were used as standards for analyses.

APPENDIX G

DISPERSION DATA GENERATED BY COMPUTER PROGRAM "PLUME"

TABLE G-1. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY B.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = B
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	20.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	5.82	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	2.73	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	1.57	0.47	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	1.03	0.45	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.6 KM	711.53	392.83	66.10	3.39	0.05	0.00	0.00	0.00	0.00	0.00
0.7 KM	523.45	332.87	85.60	8.90	0.37	0.01	0.00	0.00	0.00	0.00
0.8 KM	402.09	281.17	96.14	16.07	1.31	0.05	0.00	0.00	0.00	0.00
0.9 KM	319.07	238.60	99.77	23.33	3.05	0.22	0.01	0.00	0.00	0.00
1.0 KM	259.70	204.01	98.90	29.58	5.46	0.62	0.04	0.00	0.00	0.00
1.1 KM	214.76	176.11	94.95	34.23	8.21	1.31	0.14	0.01	0.00	0.00
1.2 KM	180.71	151.70	89.73	37.40	10.99	2.27	0.33	0.03	0.00	0.00
1.3 KM	154.29	132.54	84.01	39.29	13.56	3.45	0.65	0.09	0.01	0.00
1.4 KM	133.37	116.71	78.23	40.16	15.79	4.75	1.10	0.19	0.03	0.00
1.5 KM	116.49	103.52	72.64	40.25	17.61	6.08	1.66	0.36	0.06	0.01
1.6 KM	102.68	92.41	67.36	39.77	19.02	7.37	2.31	0.59	0.12	0.02
1.7 KM	91.23	82.99	62.46	38.90	20.05	8.55	3.02	0.88	0.21	0.04
1.8 KM	81.63	74.93	57.95	37.77	20.74	9.60	3.74	1.23	0.34	0.08
1.9 KM	73.49	67.99	53.83	36.47	21.15	10.50	4.46	1.62	0.50	0.13
2.0 KM	66.53	61.96	50.06	35.08	21.33	11.25	5.14	2.04	0.70	0.21
2.1 KM	60.35	56.54	46.49	33.55	21.25	11.81	5.76	2.47	0.93	0.31
2.2 KM	55.01	51.80	43.25	32.02	21.02	12.24	6.32	2.89	1.17	0.42
2.3 KM	50.35	47.63	40.32	30.64	20.69	12.55	6.81	3.31	1.44	0.56
2.4 KM	46.28	43.95	37.66	29.10	20.28	12.75	7.23	3.70	1.71	0.71
2.5 KM	42.69	40.69	35.24	27.72	19.81	12.86	7.59	4.07	1.98	0.88
2.6 KM	39.51	37.78	33.03	26.41	19.30	12.90	7.88	4.40	2.25	1.05
2.7 KM	36.68	35.17	31.02	25.16	18.76	12.87	8.12	4.71	2.51	1.23
2.8 KM	34.15	32.83	29.18	23.98	18.21	12.79	8.30	4.98	2.76	1.42
2.9 KM	31.87	30.72	27.50	22.86	17.65	12.66	8.43	5.22	3.00	1.60
3.0 KM	29.82	28.80	25.96	21.81	17.09	12.50	8.52	5.42	3.22	1.78
3.1 KM	27.90	26.99	24.46	20.76	16.50	12.28	8.55	5.58	3.41	1.95
3.2 KM	26.15	25.35	23.10	19.78	15.91	12.03	8.55	5.71	3.59	2.11
3.3 KM	24.57	23.86	21.84	18.86	15.35	11.78	8.52	5.82	3.74	2.27

TABLE G-2. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1000 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY B.

SOURCE STRENGTH = 1000 KILOGRAMS/HOUR (277.7778 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = B
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	13.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	3.88	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	1.82	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	1.05	0.31	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.5 KM	684.86	301.86	25.85	0.43	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	474.36	261.89	44.07	2.26	0.04	0.00	0.00	0.00	0.00	0.00
0.7 KM	348.96	221.92	57.07	5.94	0.25	0.00	0.00	0.00	0.00	0.00
0.8 KM	268.06	187.44	64.09	10.72	0.88	0.04	0.00	0.00	0.00	0.00
0.9 KM	212.72	159.07	66.51	15.55	2.03	0.15	0.01	0.00	0.00	0.00
1.0 KM	173.14	136.01	65.93	19.72	3.64	0.41	0.03	0.00	0.00	0.00
1.1 KM	143.17	116.74	63.30	22.82	5.47	0.87	0.09	0.01	0.00	0.00
1.2 KM	120.47	101.13	59.82	24.94	7.32	1.52	0.22	0.02	0.00	0.00
1.3 KM	102.86	88.36	56.01	26.20	9.04	2.30	0.43	0.06	0.01	0.00
1.4 KM	88.91	77.81	52.15	26.77	10.53	3.17	0.73	0.13	0.02	0.00
1.5 KM	77.66	69.01	48.42	26.83	11.74	4.06	1.11	0.24	0.04	0.01
1.6 KM	68.46	61.61	44.91	26.51	12.68	4.91	1.64	0.39	0.08	0.01
1.7 KM	60.82	55.33	41.64	25.94	13.37	5.70	2.01	0.59	0.14	0.03
1.8 KM	54.42	49.96	38.64	25.18	13.83	6.40	2.49	0.82	0.23	0.05
1.9 KM	48.99	45.32	35.88	24.32	14.10	7.00	2.97	1.08	0.34	0.09
2.0 KM	44.35	41.31	33.37	23.39	14.22	7.50	3.43	1.36	0.47	0.14
2.1 KM	40.23	37.69	30.99	22.36	14.16	7.87	3.84	1.64	0.62	0.20
2.2 KM	36.67	34.53	28.83	21.35	14.02	8.16	4.21	1.93	0.78	0.28
2.3 KM	33.57	31.75	26.88	20.36	13.80	8.37	4.54	2.20	0.96	0.37
2.4 KM	30.86	29.30	25.10	19.40	13.52	8.50	4.82	2.47	1.14	0.47
2.5 KM	28.46	27.13	23.49	18.48	13.21	8.58	5.06	2.71	1.32	0.58
2.6 KM	26.34	25.19	22.02	17.60	12.87	8.60	5.26	2.94	1.50	0.70
2.7 KM	24.46	23.46	20.68	16.77	12.51	8.58	5.41	3.14	1.67	0.82
2.8 KM	22.76	21.89	19.45	15.98	12.14	8.52	5.53	3.32	1.84	0.94
2.9 KM	21.25	20.48	18.33	15.24	11.77	8.44	5.62	3.48	2.00	1.07
3.0 KM	19.88	19.20	17.30	14.54	11.40	8.33	5.68	3.62	2.15	1.19
3.1 KM	18.60	18.00	16.31	13.84	11.00	8.18	5.70	3.72	2.27	1.30
3.2 KM	17.43	16.90	15.40	13.18	10.61	8.02	5.70	3.81	2.39	1.41
3.3 KM	16.38	15.91	14.56	12.57	10.23	7.85	5.68	3.88	2.49	1.51

TABLE G-3. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 500 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY B.

SOURCE STRENGTH = 500 KILOGRAMS/HOUR (138.8889 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = B
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	6.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	1.94	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.3 KM	910.23	121.19	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	524.96	155.88	4.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	342.43	150.93	12.92	0.21	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	237.18	130.94	22.03	1.13	0.02	0.00	0.00	0.00	0.00	0.00
0.7 KM	174.48	110.96	28.53	2.97	0.12	0.00	0.00	0.00	0.00	0.00
0.8 KM	134.03	93.72	32.05	5.36	0.44	0.02	0.00	0.00	0.00	0.00
0.9 KM	106.36	79.53	33.26	7.78	1.02	0.07	0.00	0.00	0.00	0.00
1.0 KM	86.57	68.00	32.97	9.86	1.82	0.21	0.01	0.00	0.00	0.00
1.1 KM	71.68	58.37	31.65	11.41	2.74	0.44	0.05	0.00	0.00	0.00
1.2 KM	60.24	50.57	29.91	12.47	3.66	0.76	0.11	0.01	0.00	0.00
1.3 KM	51.43	44.18	28.00	13.10	4.52	1.15	0.22	0.03	0.00	0.00
1.4 KM	44.46	38.90	26.08	13.39	5.26	1.68	0.37	0.06	0.01	0.00
1.5 KM	38.83	34.61	24.21	13.42	5.87	2.03	0.55	0.12	0.02	0.00
1.6 KM	34.23	30.80	22.45	13.26	6.34	2.46	0.77	0.20	0.04	0.01
1.7 KM	30.41	27.66	20.82	12.97	6.68	2.85	1.01	0.29	0.07	0.01
1.8 KM	27.21	24.98	19.32	12.59	6.91	3.20	1.25	0.41	0.11	0.03
1.9 KM	24.50	22.66	17.94	12.16	7.05	3.50	1.49	0.54	0.17	0.04
2.0 KM	22.18	20.65	16.69	11.69	7.11	3.75	1.71	0.68	0.23	0.07
2.1 KM	20.12	18.85	15.50	11.18	7.09	3.94	1.92	0.82	0.31	0.10
2.2 KM	18.34	17.27	14.42	10.67	7.01	4.08	2.11	0.96	0.39	0.14
2.3 KM	16.78	15.88	13.44	10.18	6.90	4.18	2.27	1.10	0.48	0.19
2.4 KM	15.43	14.65	12.55	9.70	6.76	4.25	2.41	1.23	0.57	0.24
2.5 KM	14.23	13.56	11.75	9.24	6.60	4.29	2.53	1.36	0.66	0.29
2.6 KM	13.17	12.59	11.01	8.80	6.43	4.30	2.63	1.47	0.75	0.35
2.7 KM	12.23	11.72	10.34	8.39	6.25	4.29	2.71	1.57	0.84	0.41
2.8 KM	11.38	10.94	9.73	7.99	6.07	4.26	2.77	1.66	0.92	0.47
2.9 KM	10.62	10.24	9.17	7.62	5.88	4.22	2.81	1.74	1.00	0.53
3.0 KM	9.94	9.60	8.65	7.27	5.70	4.17	2.84	1.81	1.07	0.59
3.1 KM	9.30	9.00	8.15	6.92	5.50	4.09	2.85	1.86	1.14	0.65
3.2 KM	8.72	8.45	7.70	6.59	5.30	4.01	2.85	1.90	1.20	0.70
3.3 KM	8.19	7.95	7.28	6.29	5.12	3.93	2.84	1.94	1.25	0.76

TABLE G-4. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 100 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY B.

SOURCE STRENGTH = 100 KILOGRAMS/HOUR (27.77778 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = B
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.2 KM	387.82	6.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	182.05	24.24	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	104.99	31.18	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	68.49	30.19	2.58	0.04	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	47.44	26.19	4.41	0.23	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	34.90	22.19	5.71	0.59	0.02	0.00	0.00	0.00	0.00	0.00
0.8 KM	26.81	18.74	6.41	1.07	0.09	0.00	0.00	0.00	0.00	0.00
0.9 KM	21.27	15.91	6.65	1.56	0.20	0.01	0.00	0.00	0.00	0.00
1.0 KM	17.31	13.60	6.59	1.97	0.36	0.04	0.00	0.00	0.00	0.00
1.1 KM	14.32	11.67	6.33	2.28	0.55	0.09	0.01	0.00	0.00	0.00
1.2 KM	12.05	10.11	5.98	2.49	0.73	0.15	0.02	0.00	0.00	0.00
1.3 KM	10.29	8.84	5.60	2.62	0.90	0.23	0.04	0.01	0.00	0.00
1.4 KM	8.89	7.78	5.22	2.68	1.05	0.32	0.07	0.01	0.00	0.00
1.5 KM	7.77	6.90	4.84	2.68	1.17	0.41	0.11	0.02	0.00	0.00
1.6 KM	6.85	6.16	4.49	2.65	1.27	0.49	0.15	0.04	0.01	0.00
1.7 KM	6.08	5.53	4.16	2.59	1.34	0.57	0.20	0.06	0.01	0.00
1.8 KM	5.44	5.00	3.86	2.52	1.38	0.64	0.25	0.08	0.02	0.01
1.9 KM	4.90	4.53	3.59	2.43	1.41	0.70	0.30	0.11	0.03	0.01
2.0 KM	4.44	4.13	3.34	2.34	1.42	0.75	0.34	0.14	0.05	0.01
2.1 KM	4.02	3.77	3.10	2.24	1.42	0.79	0.38	0.16	0.06	0.02
2.2 KM	3.67	3.45	2.88	2.13	1.40	0.82	0.42	0.19	0.08	0.03
2.3 KM	3.36	3.18	2.69	2.04	1.38	0.84	0.45	0.22	0.10	0.04
2.4 KM	3.09	2.93	2.51	1.94	1.35	0.85	0.48	0.25	0.11	0.05
2.5 KM	2.85	2.71	2.35	1.85	1.32	0.86	0.51	0.27	0.13	0.06
2.6 KM	2.63	2.52	2.20	1.76	1.29	0.86	0.53	0.29	0.15	0.07
2.7 KM	2.45	2.34	2.07	1.68	1.25	0.86	0.54	0.31	0.17	0.08
2.8 KM	2.28	2.19	1.95	1.60	1.21	0.85	0.55	0.33	0.18	0.09
2.9 KM	2.12	2.05	1.83	1.52	1.18	0.84	0.56	0.35	0.20	0.11
3.0 KM	1.99	1.92	1.73	1.45	1.14	0.83	0.57	0.36	0.21	0.12
3.1 KM	1.86	1.80	1.63	1.38	1.10	0.82	0.57	0.37	0.23	0.13
3.2 KM	1.74	1.69	1.54	1.32	1.06	0.80	0.57	0.38	0.24	0.14
3.3 KM	1.64	1.59	1.46	1.26	1.02	0.79	0.57	0.39	0.25	0.15

TABLE G-5. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 1 m/s. STABILITY CATEGORY A.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 1 METERS/SECOND (2.2369363 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = A
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
					CONCENTRATION IN PPM BY VOLUME					
0.1 KM	32.25	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	8.47	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	3.69	1.33	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	1.87	1.01	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00
					CONCENTRATION IN PPB BY VOLUME					
0.5 KM	977.80	642.90	182.73	22.45	1.19	0.03	0.00	0.00	0.00	0.00
0.6 KM	524.51	386.42	154.52	33.54	3.95	0.25	0.01	0.00	0.00	0.00
0.7 KM	334.51	264.77	131.31	40.80	7.94	0.97	0.07	0.00	0.00	0.00
0.8 KM	234.39	194.73	111.65	44.18	12.07	2.27	0.39	0.03	0.00	0.00
0.9 KM	174.43	149.96	95.30	44.77	15.54	3.99	0.76	0.11	0.01	0.00
1.0 KM	135.39	119.38	81.84	43.62	18.08	5.82	1.46	0.28	0.04	0.01
1.1 KM	93.81	84.32	61.23	35.92	17.03	6.52	2.02	0.50	0.10	0.02
1.2 KM	69.74	63.63	48.33	30.55	16.08	7.05	2.57	0.78	0.20	0.04
1.3 KM	54.29	50.13	39.46	26.48	15.14	7.38	3.07	1.09	0.33	0.08
1.4 KM	43.68	40.72	32.99	23.23	14.22	7.56	3.49	1.40	0.49	0.15
1.5 KM	36.03	33.85	28.09	20.58	13.31	7.60	3.83	1.71	0.67	0.23
1.6 KM	30.30	28.66	24.25	18.36	12.44	7.54	4.09	1.98	0.86	0.33
1.7 KM	25.88	24.62	21.18	16.49	11.61	7.40	4.27	2.22	1.06	0.45
1.8 KM	22.40	21.41	18.68	14.89	10.84	7.21	4.38	2.43	1.23	0.57
1.9 KM	19.60	18.80	16.61	13.51	10.12	6.98	4.43	2.59	1.40	0.69
2.0 KM	17.31	16.66	14.88	12.32	9.46	6.73	4.44	2.72	1.54	0.81
2.1 KM	14.70	14.20	12.80	10.76	8.44	6.18	4.22	2.69	1.60	0.88
2.2 KM	12.68	12.28	11.16	9.51	7.60	5.70	4.01	2.64	1.63	0.95
2.3 KM	11.07	10.75	9.83	8.48	6.89	5.28	3.81	2.59	1.65	1.00
2.4 KM	9.77	9.50	8.75	7.62	6.29	4.91	3.63	2.54	1.68	1.05
2.5 KM	8.69	8.47	7.84	6.90	5.77	4.58	3.45	2.47	1.68	1.09
2.6 KM	7.79	7.60	7.08	6.28	5.31	4.28	3.29	2.41	1.68	1.12
2.7 KM	7.03	6.87	6.43	5.74	4.91	4.01	3.13	2.34	1.67	1.14
2.8 KM	6.38	6.25	5.86	5.28	4.55	3.77	2.99	2.27	1.66	1.16
2.9 KM	5.82	5.71	5.38	4.87	4.24	3.55	2.85	2.20	1.64	1.17
3.0 KM	5.33	5.23	4.95	4.51	3.96	3.34	2.72	2.14	1.61	1.17

TABLE G-6. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 2 m/s. STABILITY CATEGORY A.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 2 METERS/SECOND (4.4738726 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = A
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	16.13	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	4.24	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	1.84	0.67	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.4 KM	934.83	504.01	78.99	3.60	0.05	0.00	0.00	0.00	0.00	0.00
0.5 KM	488.90	321.45	91.36	11.23	0.60	0.01	0.00	0.00	0.00	0.00
0.6 KM	262.25	193.21	77.26	16.77	1.98	0.13	0.00	0.00	0.00	0.00
0.7 KM	167.25	132.39	65.65	20.40	3.97	0.48	0.04	0.00	0.00	0.00
0.8 KM	117.20	97.36	55.83	22.09	6.03	1.14	0.15	0.01	0.00	0.00
0.9 KM	87.21	74.98	47.65	22.38	7.77	1.99	0.38	0.05	0.01	0.00
1.0 KM	67.69	59.69	40.92	21.81	9.04	2.91	0.73	0.14	0.02	0.00
1.1 KM	46.91	42.16	30.62	17.96	8.51	3.26	1.01	0.25	0.05	0.01
1.2 KM	34.87	31.81	24.16	15.28	8.04	3.52	1.28	0.39	0.10	0.02
1.3 KM	27.15	25.06	19.73	13.24	7.57	3.69	1.53	0.54	0.16	0.04
1.4 KM	21.84	20.36	16.50	11.62	7.11	3.78	1.75	0.70	0.24	0.07
1.5 KM	18.01	16.93	14.04	10.29	6.65	3.80	1.92	0.85	0.34	0.12
1.6 KM	15.15	14.33	12.13	9.18	6.22	3.77	2.04	0.99	0.43	0.17
1.7 KM	12.94	12.31	10.59	8.25	5.81	3.70	2.13	1.11	0.52	0.22
1.8 KM	11.20	10.70	9.34	7.45	5.42	3.60	2.19	1.21	0.61	0.28
1.9 KM	9.80	9.40	8.31	6.76	5.06	3.49	2.22	1.30	0.70	0.35
2.0 KM	8.65	8.33	7.44	6.16	4.73	3.37	2.22	1.36	0.77	0.41
2.1 KM	7.35	7.10	6.40	5.38	4.22	3.09	2.11	1.34	0.80	0.44
2.2 KM	6.34	6.14	5.58	4.75	3.80	2.85	2.00	1.32	0.82	0.47
2.3 KM	5.54	5.37	4.92	4.24	3.45	2.64	1.90	1.30	0.83	0.50
2.4 KM	4.88	4.75	4.37	3.81	3.14	2.45	1.81	1.27	0.84	0.53
2.5 KM	4.34	4.23	3.92	3.45	2.88	2.29	1.73	1.24	0.84	0.54
2.6 KM	3.89	3.80	3.54	3.14	2.65	2.14	1.64	1.20	0.84	0.56
2.7 KM	3.51	3.44	3.21	2.87	2.45	2.01	1.57	1.17	0.84	0.57
2.8 KM	3.19	3.12	2.93	2.64	2.28	1.88	1.49	1.14	0.83	0.58
2.9 KM	2.91	2.85	2.69	2.43	2.12	1.77	1.43	1.10	0.82	0.58
3.0 KM	2.67	2.62	2.47	2.25	1.98	1.67	1.36	1.07	0.81	0.59

TABLE G-7. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 5 m/s. STABILITY CATEGORY B.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 5 METERS/SECOND (11.1846815 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = B
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	12.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	3.49	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	1.64	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.4 KM	944.92	280.59	7.35	0.02	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	616.38	271.67	23.26	0.39	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	426.92	235.70	39.66	2.03	0.03	0.00	0.00	0.00	0.00	0.00
0.7 KM	314.07	199.72	51.36	5.34	0.22	0.00	0.00	0.00	0.00	0.00
0.8 KM	241.25	168.70	57.68	9.64	0.79	0.03	0.00	0.00	0.00	0.00
0.9 KM	191.44	143.16	59.86	14.00	1.83	0.13	0.01	0.00	0.00	0.00
1.0 KM	155.82	122.41	59.34	17.75	3.28	0.37	0.03	0.00	0.00	0.00
1.1 KM	128.85	105.07	56.97	20.54	4.92	0.78	0.08	0.01	0.00	0.00
1.2 KM	108.43	91.02	53.84	22.44	6.59	1.36	0.20	0.02	0.00	0.00
1.3 KM	92.58	79.52	50.41	23.58	8.14	2.07	0.39	0.05	0.01	0.00
1.4 KM	80.02	70.03	46.94	24.09	9.47	2.85	0.66	0.12	0.02	0.00
1.5 KM	69.90	62.11	43.58	24.15	10.57	3.65	1.00	0.21	0.04	0.00
1.6 KM	61.61	55.45	40.42	23.86	11.41	4.42	1.39	0.35	0.07	0.01
1.7 KM	54.74	49.79	37.48	23.34	12.03	5.13	1.81	0.53	0.13	0.03
1.8 KM	48.98	44.96	34.77	22.66	12.45	5.76	2.25	0.74	0.20	0.05
1.9 KM	44.09	40.79	32.30	21.88	12.69	6.30	2.68	0.97	0.30	0.08
2.0 KM	39.92	37.18	30.04	21.05	12.80	6.75	3.09	1.22	0.42	0.13
2.1 KM	36.21	33.92	27.89	20.13	12.75	7.09	3.46	1.48	0.56	0.18
2.2 KM	33.00	31.08	25.95	19.21	12.61	7.34	3.79	1.74	0.70	0.25
2.3 KM	30.21	28.58	24.19	18.32	12.42	7.53	4.09	1.98	0.86	0.33
2.4 KM	27.77	26.37	22.59	17.46	12.17	7.65	4.34	2.22	1.02	0.43
2.5 KM	25.61	24.41	21.14	16.63	11.89	7.72	4.55	2.44	1.19	0.53
2.6 KM	23.71	22.67	19.82	15.84	11.58	7.74	4.73	2.64	1.35	0.63
2.7 KM	22.01	21.10	18.61	15.09	11.26	7.72	4.87	2.83	1.51	0.74
2.8 KM	20.49	19.70	17.51	14.39	10.93	7.67	4.98	2.99	1.66	0.85
2.9 KM	19.12	18.43	16.50	13.72	10.59	7.60	5.06	3.13	1.80	0.96
3.0 KM	17.89	17.28	15.57	13.08	10.26	7.50	5.11	3.25	1.93	1.07
3.1 KM	16.74	16.20	14.68	12.46	9.90	7.37	5.13	3.35	2.05	1.17
3.2 KM	15.69	15.21	13.86	11.87	9.55	7.22	5.13	3.43	2.15	1.27
3.3 KM	14.74	14.32	13.11	11.31	9.21	7.07	5.11	3.49	2.24	1.36

TABLE G-8. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 10 m/s. STABILITY CATEGORY C.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 10 METERS/SECOND (22.369363 MILES/HOUR)
DAY WITH CLOUD COVER = 0 PERCENT
SOLAR ANGLE = 90 DEGREES
STABILITY CATEGORY = C
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	13.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	3.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	1.83	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	1.09	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
0.5 KM	718.13	119.26	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	519.65	142.60	2.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	394.24	147.99	7.83	0.06	0.00	0.00	0.00	0.00	0.00	0.00
0.8 KM	309.81	143.37	14.21	0.30	0.00	0.00	0.00	0.00	0.00	0.00
0.9 KM	250.18	134.14	20.67	0.92	0.01	0.00	0.00	0.00	0.00	0.00
1.0 KM	206.45	123.27	26.24	1.99	0.05	0.00	0.00	0.00	0.00	0.00
1.1 KM	174.30	112.89	30.67	3.50	0.17	0.00	0.00	0.00	0.00	0.00
1.2 KM	149.22	102.93	33.78	5.27	0.39	0.01	0.00	0.00	0.00	0.00
1.3 KM	129.28	93.72	35.71	7.15	0.75	0.04	0.00	0.00	0.00	0.00
1.4 KM	113.11	85.37	36.70	8.99	1.25	0.10	0.00	0.00	0.00	0.00
1.5 KM	99.86	77.88	36.95	10.66	1.87	0.20	0.01	0.00	0.00	0.00
1.6 KM	88.83	71.20	36.65	12.12	2.58	0.35	0.03	0.00	0.00	0.00
1.7 KM	79.56	65.24	36.98	13.34	3.33	0.56	0.06	0.00	0.00	0.00
1.8 KM	71.70	59.94	35.03	14.31	4.09	0.82	0.11	0.01	0.00	0.00
1.9 KM	64.96	55.22	33.92	15.06	4.83	1.12	0.19	0.02	0.00	0.00
2.0 KM	59.14	51.00	32.70	15.59	5.53	1.46	0.29	0.04	0.00	0.00
2.1 KM	53.97	47.13	31.37	15.92	6.16	1.82	0.41	0.07	0.01	0.00
2.2 KM	49.46	43.66	30.03	16.09	6.72	2.19	0.55	0.11	0.02	0.00
2.3 KM	45.51	40.56	28.71	16.14	7.21	2.56	0.72	0.16	0.03	0.00
2.4 KM	42.01	37.76	27.42	16.08	7.62	2.92	0.90	0.23	0.05	0.01
2.5 KM	38.91	35.24	26.18	15.95	7.97	3.27	1.10	0.30	0.07	0.01
2.6 KM	36.15	32.96	24.98	15.74	8.25	3.59	1.30	0.39	0.10	0.02
2.7 KM	33.67	30.89	23.84	15.49	8.46	3.89	1.51	0.49	0.13	0.03
2.8 KM	31.45	29.00	22.76	15.19	8.63	4.17	1.71	0.60	0.18	0.05
2.9 KM	29.44	27.29	21.73	14.87	8.74	4.42	1.92	0.71	0.23	0.06
3.0 KM	27.62	25.71	20.76	14.53	8.81	4.64	2.11	0.84	0.29	0.09
3.1 KM	26.04	24.36	19.89	14.21	8.87	4.84	2.31	0.96	0.35	0.11
3.2 KM	24.60	23.08	19.07	13.88	8.90	5.02	2.49	1.09	0.42	0.14
3.3 KM	23.27	21.91	18.29	13.54	8.89	5.17	2.67	1.22	0.50	0.18

TABLE G-9. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY D.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
DAY WITH CLOUD COVER = 100 PERCENT
SOLAR ANGLE = 0 DEGREES
STABILITY CATEGORY = D
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	111.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	32.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	15.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	9.50	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	6.47	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	4.81	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	3.73	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.8 KM	2.98	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.9 KM	2.44	0.56	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0 KM	2.03	0.60	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1 KM	1.76	0.63	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2 KM	1.54	0.64	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3 KM	1.37	0.64	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4 KM	1.22	0.63	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5 KM	1.09	0.61	0.10	0.01	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
1.6 KM	985.80	584.08	121.49	8.87	0.23	0.00	0.00	0.00	0.00	0.00
1.7 KM	894.75	559.70	137.00	13.12	0.49	0.01	0.00	0.00	0.00	0.00
1.8 KM	816.05	534.50	150.19	18.10	0.94	0.02	0.00	0.00	0.00	0.00
1.9 KM	747.53	509.27	161.03	23.63	1.61	0.05	0.00	0.00	0.00	0.00
2.0 KM	687.48	484.53	169.63	29.50	2.55	0.11	0.00	0.00	0.00	0.00
2.1 KM	639.00	463.85	177.42	35.76	3.80	0.21	0.01	0.00	0.00	0.00
2.2 KM	595.64	443.68	183.36	42.05	5.35	0.38	0.01	0.00	0.00	0.00
2.3 KM	556.70	424.20	187.68	48.21	7.19	0.62	0.03	0.00	0.00	0.00
2.4 KM	521.67	406.50	190.56	54.13	9.29	0.96	0.06	0.00	0.00	0.00
2.5 KM	489.77	387.65	192.21	59.70	11.62	1.42	0.11	0.01	0.00	0.00
2.6 KM	460.88	370.66	192.81	64.88	14.12	1.99	0.18	0.01	0.00	0.00
2.7 KM	434.54	354.53	192.54	69.60	16.75	2.68	0.29	0.02	0.00	0.00

TABLE G-10. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY E.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
NIGHT WITH CLOUD COVER = 70 PERCENT
STABILITY CATEGORY = E
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
				CONCENTRATION IN PPM BY VOLUME						
0.1 KM	194.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	57.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	29.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	17.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	12.36	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	9.24	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	7.19	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.8 KM	5.77	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.9 KM	4.74	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0 KM	3.96	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1 KM	3.44	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2 KM	3.02	0.64	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3 KM	2.67	0.69	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4 KM	2.39	0.73	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5 KM	2.14	0.76	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.6 KM	1.94	0.77	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.7 KM	1.76	0.77	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.8 KM	1.61	0.76	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.9 KM	1.47	0.75	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.0 KM	1.35	0.73	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.1 KM	1.26	0.72	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.2 KM	1.18	0.70	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.3 KM	1.11	0.68	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.4 KM	1.04	0.67	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00
				CONCENTRATION IN PPB BY VOLUME						
2.5 KM	978.01	646.90	187.21	23.70	1.31	0.03	0.00	0.00	0.00	0.00
2.6 KM	922.38	627.61	197.71	28.83	1.95	0.06	0.00	0.00	0.00	0.00
2.7 KM	871.54	608.26	206.77	34.24	2.76	0.11	0.00	0.00	0.00	0.00
2.8 KM	824.93	589.05	214.47	39.82	3.77	0.18	0.00	0.00	0.00	0.00
2.9 KM	782.09	570.14	220.86	45.48	4.98	0.29	0.01	0.00	0.00	0.00
3.0 KM	742.61	551.63	226.10	51.13	6.38	0.44	0.02	0.00	0.00	0.00
3.1 KM	708.76	535.56	231.07	56.93	8.01	0.64	0.03	0.00	0.00	0.00
3.2 KM	677.28	519.83	235.05	62.61	9.83	0.91	0.05	0.00	0.00	0.00
3.3 KM	647.94	504.49	238.12	68.13	11.82	1.24	0.08	0.00	0.00	0.00

TABLE G-11. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 3 m/s. STABILITY CATEGORY F.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 3 METERS/SECOND (6.7108089 MILES/HOUR)
NIGHT WITH CLOUD COVER = 30 PERCENT
STABILITY CATEGORY = F
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
			CONCENTRATION IN PPM BY VOLUME							
0.1 KM	444.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.2 KM	135.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	67.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	41.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	28.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	21.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	16.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.8 KM	13.34	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.9 KM	10.97	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0 KM	9.19	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1 KM	7.99	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2 KM	7.02	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3 KM	6.22	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4 KM	5.55	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5 KM	4.99	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.6 KM	4.51	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.7 KM	4.10	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.8 KM	3.74	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.9 KM	3.43	0.75	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.0 KM	3.16	0.79	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1 KM	2.96	0.83	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2 KM	2.77	0.86	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3 KM	2.61	0.88	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4 KM	2.45	0.90	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5 KM	2.32	0.91	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6 KM	2.19	0.92	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7 KM	2.07	0.92	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8 KM	1.97	0.92	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.9 KM	1.87	0.92	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.0 KM	1.78	0.91	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.1 KM	1.70	0.91	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3.2 KM	1.63	0.90	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3.3 KM	1.57	0.89	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00

TABLE G-12. DISPERSION DATA FOR HALON 2402 AT SOURCE STRENGTH OF 1500 kg/hr AND WIND VELOCITY OF 1 m/s. STABILITY CATEGORY F.

SOURCE STRENGTH = 1500 KILOGRAMS/HOUR (416.6667 GRAMS/SECOND)
WIND VELOCITY = 1 METERS/SECOND (2.2369363 MILES/HOUR)
NIGHT WITH CLOUD COVER = 30 PERCENT
STABILITY CATEGORY = F
TEMPERATURE = 20 DEGREES CELCIUS
PRESSURE = 760 TORR
MOLECULAR WEIGHT = 259.83

	0 m	100 m	200 m	300 m	400 m	500 m	600 m	700 m	800 m	900 m
	CONCENTRATION IN PARTS PER THOUSAND BY VOLUME									
0.1 KM	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CONCENTRATION IN PPM BY VOLUME									
0.2 KM	405.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.3 KM	203.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.4 KM	124.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.5 KM	84.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.6 KM	63.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.7 KM	49.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.8 KM	40.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.9 KM	32.91	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.0 KM	27.57	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.1 KM	23.97	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.2 KM	21.05	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.3 KM	18.65	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.4 KM	16.65	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.5 KM	14.97	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.6 KM	13.53	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.7 KM	12.30	1.90	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.8 KM	11.23	2.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.9 KM	10.30	2.24	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.0 KM	9.48	2.36	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.1 KM	8.87	2.48	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.2 KM	8.32	2.58	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.3 KM	7.82	2.65	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.4 KM	7.36	2.71	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.5 KM	6.96	2.74	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.6 KM	6.57	2.76	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.7 KM	6.22	2.77	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.8 KM	5.90	2.77	0.28	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2.9 KM	5.61	2.76	0.33	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3.0 KM	5.34	2.74	0.37	0.01	0.00	0.00	0.00	0.00	0.00	0.00
3.1 KM	5.11	2.72	0.41	0.02	0.00	0.00	0.00	0.00	0.00	0.00
3.2 KM	4.90	2.70	0.45	0.02	0.00	0.00	0.00	0.00	0.00	0.00
3.3 KM	4.70	2.67	0.49	0.03	0.00	0.00	0.00	0.00	0.00	0.00

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APPENDIX H

CHROMATOGRAPHIC DATA AND GRAPHS FOR PURITY ANALYSIS

TABLE H-1. CHROMATOGRAPHIC DATA FROM HP 5880A.

Sample number	Aliquot size µl	Halon peak Area, %	Halon peak Retention time, min	Impurity peak Area, %	Impurity peak Retention time, min
1	0.8	99.938	0.81	0.062	1.50
	3.0	99.244	0.96	0.756	1.57
2	0.8	99.943	0.96	0.756	1.57
3	0.8	99.954	0.81	0.046	1.49
4	0.8	99.934	0.81	0.066	1.49
	1.5	99.900	0.85	0.100	1.51
5	1.5	99.692	0.87	0.308	1.51
6	1.5	100.000	0.85		

TABLE H-2. RETENTION TIMES AND AREAS FOR 5890A GC CHROMATOGRAMS.

Sample	Chromatogram 1	Chromatogram 2	Chromatogram 3
1	1.31(0.009)	1.31(0.010)	1.31(0.004)
	1.36(0.020)	1.36(0.019)	1.35(0.020)
	1.42(0.002)	1.42(0.001)	1.41(0.001)
	1.56(99.835)	1.57(99.858)	1.55(99.873)
	2.19(0.090)	2.19(0.091)	2.18(0.079)
	4.00(0.009)	4.00(0.001)	3.99(0.001)
2			
	1.31(0.002)	1.32(0.001)	1.32(0.001)
	1.35(0.013)	1.35(0.013)	1.35(0.012)
	1.41(0.001)	1.41(0.001)	1.41(0.001)
	1.56(99.753)	1.56(99.746)	1.55(99.721)
	2.18(0.188)	2.18(0.186)	2.16(0.207)
	3.74(0.005)	3.74(0.001)	3.72(0.001)
	3.98(0.002)	3.99(0.001)	3.96(0.003)
	4.66(0.001)	4.67(0.002)	4.65(0.002)
	5.57(<0.001)	5.57(0.001)	5.56(0.001)
	7.33(0.001)	7.33(0.001)	7.33(0.001)
	7.59(0.002)	7.59(0.001)	7.59(0.002)
	7.65(0.001)	7.65(0.001)	7.64(0.001)
	8.81(0.004)	8.81(0.005)	8.81(0.005)
	9.22(0.002)	9.22(0.002)	9.22(0.002)
	9.55(0.001)	9.55(0.001)	9.55(0.002)
	10.42(0.005)	10.42(0.006)	10.42(0.003)
	10.64(0.008)	10.64(0.010)	10.64(0.010)
	10.72(0.002)	10.72(0.002)	10.72(0.002)
	10.78(0.001)	10.78(0.001)	10.78(0.001)

TABLE H-2. RETENTION TIMES AND AREAS FOR 5890A GC CHROMATOGRAMS (CONTINUED).

Sample	Chromatogram 1	Chromatogram 2	Chromatogram 3
3	1.31(0.003)	1.31(0.003)	1.31(0.006)
	1.35(0.014)	1.35(0.013)	1.35(0.015)
	1.41(0.003)	1.41(0.003)	1.41(0.004)
	1.55(97.938)	1.55(98.002)	1.55(98.286)
	1.75(0.004)	1.75(0.004)	1.75(0.004)
	2.17(0.099)	2.17(0.103)	2.18(0.104)
	3.98(0.001)	3.98(0.001)	3.98(0.001)
	5.56(0.001)	5.56(0.006)	5.57(0.001)
	6.16(0.015)	6.16(0.016)	6.16(0.016)
	8.86(1.886)	8.86(1.848)	8.86(1.520)
	10.64(0.001)	10.64(0.002)	10.64(0.003)
4	1.35(0.004)	1.35(0.004)	1.35(0.004)
	1.55(99.797)	1.56(99.827)	1.55(99.827)
	2.18(0.127)	2.17(0.142)	2.17(0.137)
	7.33(0.002)	7.34(0.001)	7.33(<0.001)
	7.59(0.001)	7.60(0.002)	7.59(0.001)
	8.81(0.005)	8.81(0.003)	8.81(0.003)
	9.22(0.005)	9.22(0.001)	9.22(0.001)
	10.42(0.002)	10.42(0.002)	10.42(0.002)
	10.64(0.005)	10.64(0.005)	10.64(0.005)
	10.72(0.001)	10.72(0.001)	10.72(0.001)

TABLE H-2. RETENTION TIMES AND AREAS FOR 5890A GC CHROMATOGRAMS (CONCLUDED).

Sample	Chromatogram 1	Chromatogram 2	Chromatogram 3
5	1.32(0.001)	1.32(0.001)	1.32(0.001)
	1.35(0.009)	1.35(0.008)	1.35(0.008)
	1.41(0.002)	1.41(0.002)	1.41(0.002)
	1.55(99.824)	1.56(99.888)	1.56(99.851)
	2.18(0.076)	2.18(0.082)	2.17(0.086)
	3.98(0.002)	3.98(<0.001)	3.98(0.001)
	4.66(0.013)	4.66(0.001)	4.66(0.011)
	5.57(0.027)	5.57(0.005)	5.56(0.010)
	8.80(0.003)	8.80(0.002)	8.80(0.002)
	10.63(0.004)	10.63(0.002)	10.63(0.002)
6	1.34(0.002)	1.35(0.004)	1.35(0.002)
	1.40(0.007)	1.40(0.007)	1.40(0.006)
	1.51(99.885)	1.52(99.844)	1.52(99.902)
	2.01(0.014)	2.02(0.015)	2.02(0.016)
	3.82(0.005)	3.82(0.005)	3.82(0.006)
	5.19(0.026)	5.19(0.036)	5.19(0.028)
	5.49(0.003)	5.49(0.003)	5.49(0.004)
	6.18(0.001)	6.18(0.001)	6.18(0.004)
	6.73(0.003)	6.74(0.005)	6.73(0.001)

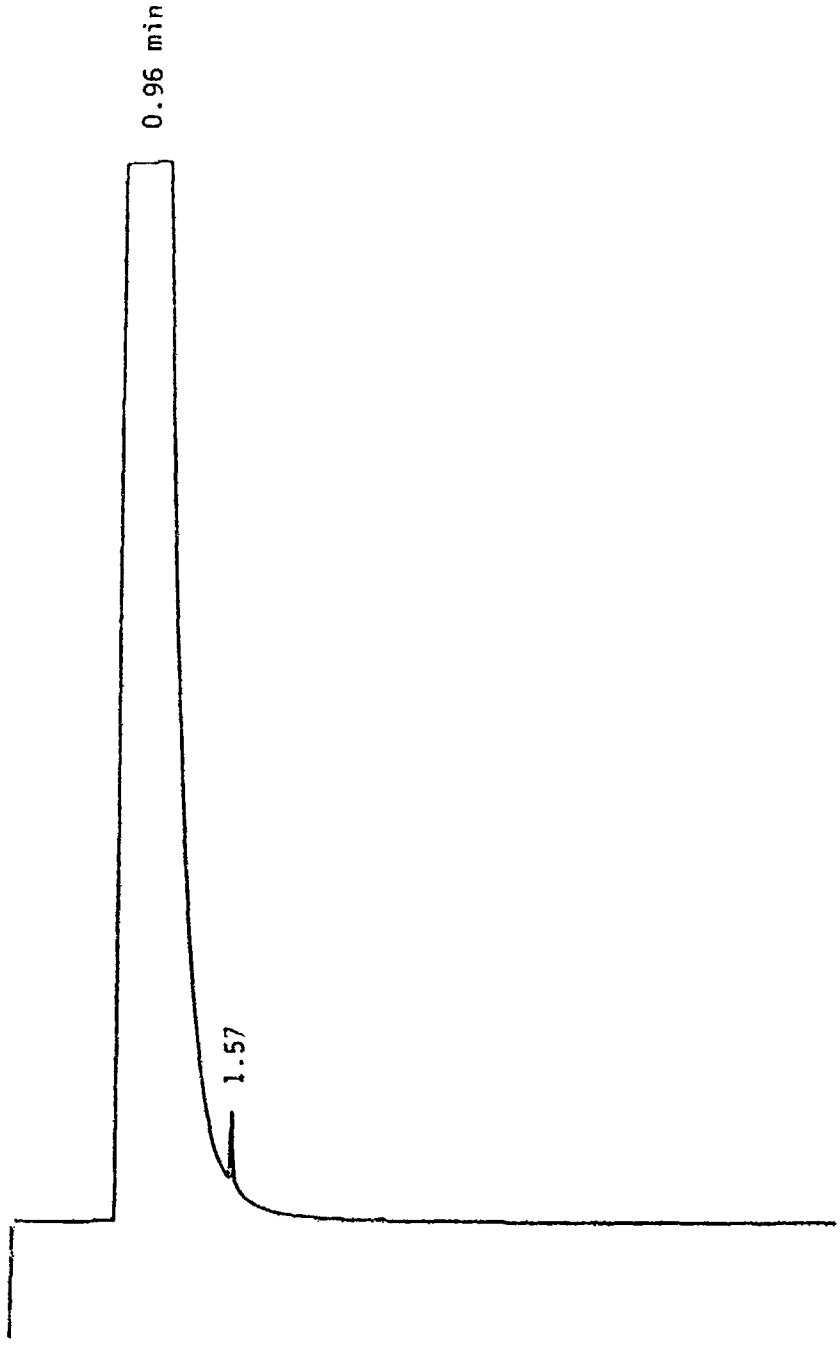

Figure H-1. Chromatograph of Sample 1 Recorded on the HP 5880A GC.

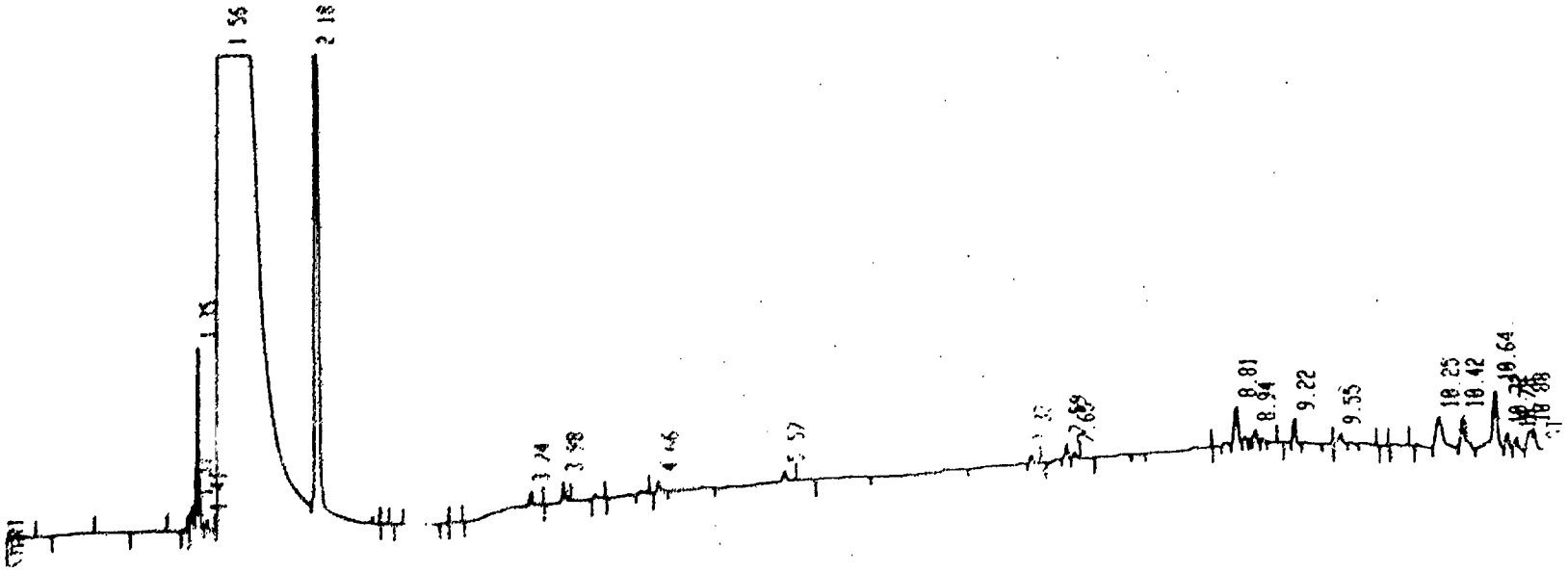

Figure H-2. Chromatogram of Sample 2 from HP 5890A Gas Chromatograph.

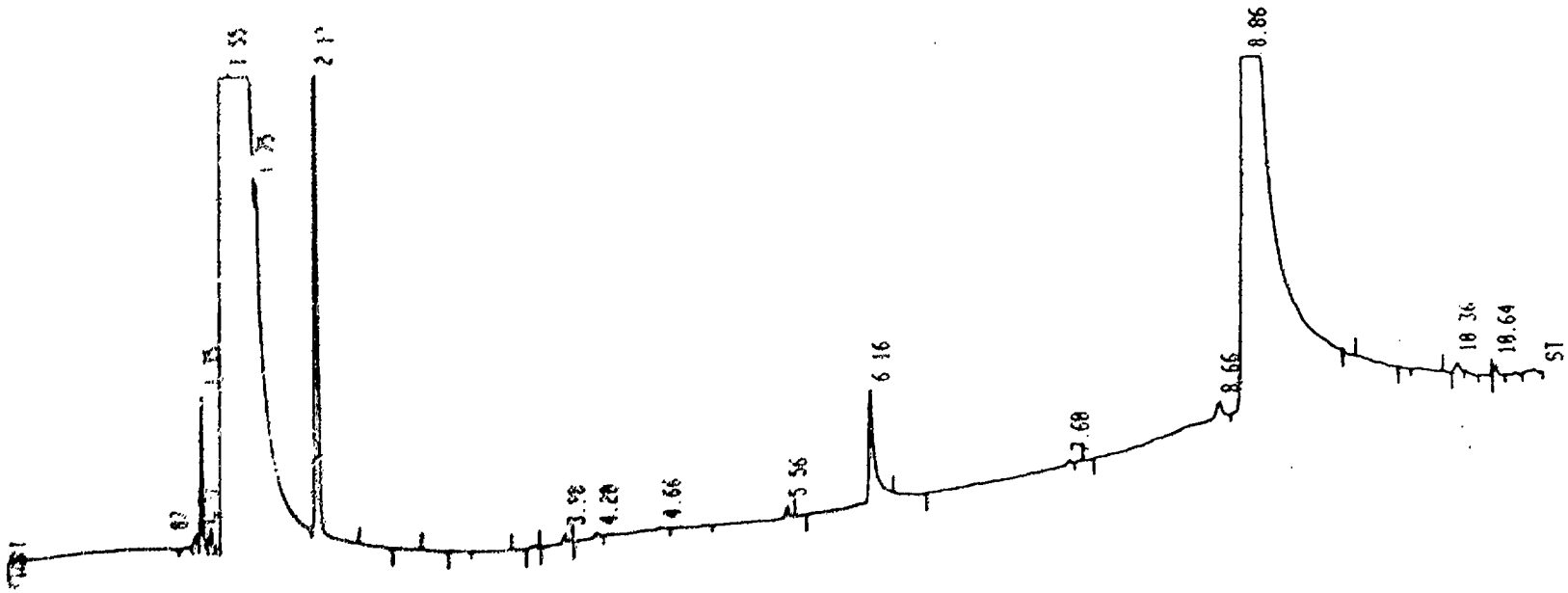

Figure H-3. Chromatogram of Sample 3 from HP 5890A Gas Chromatograph.

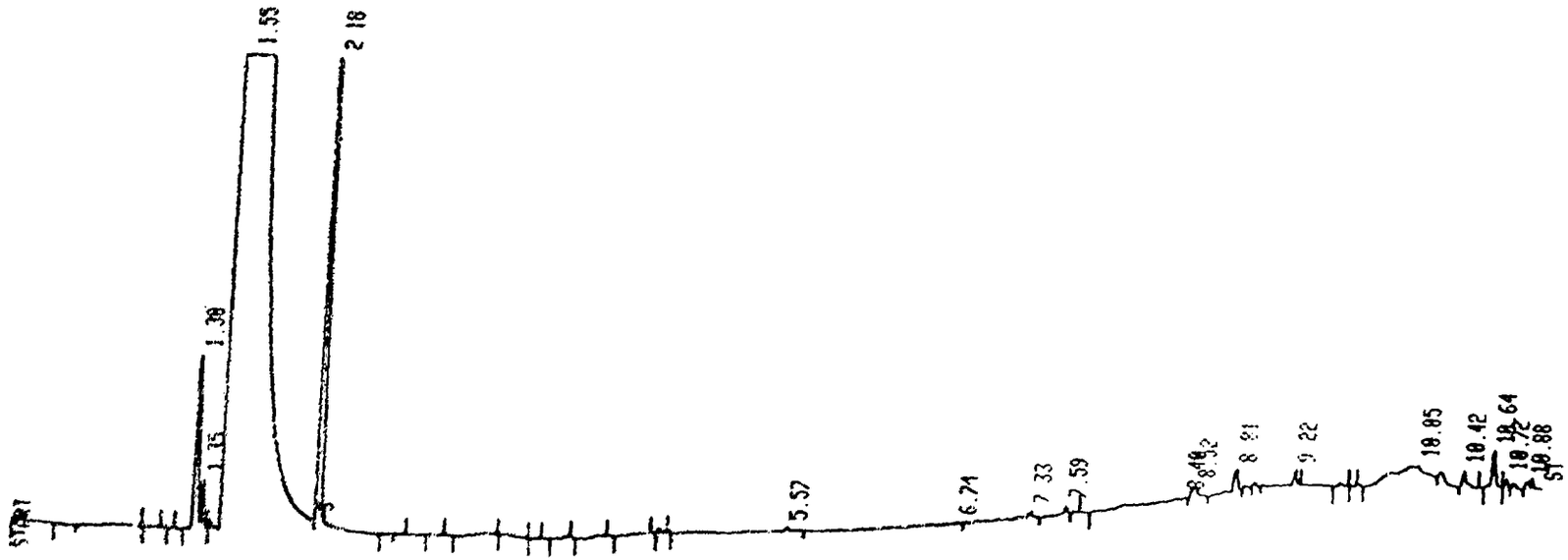

Figure H-4. Chromatogram of Sample 4 from HP 5890A Gas Chromatograph.

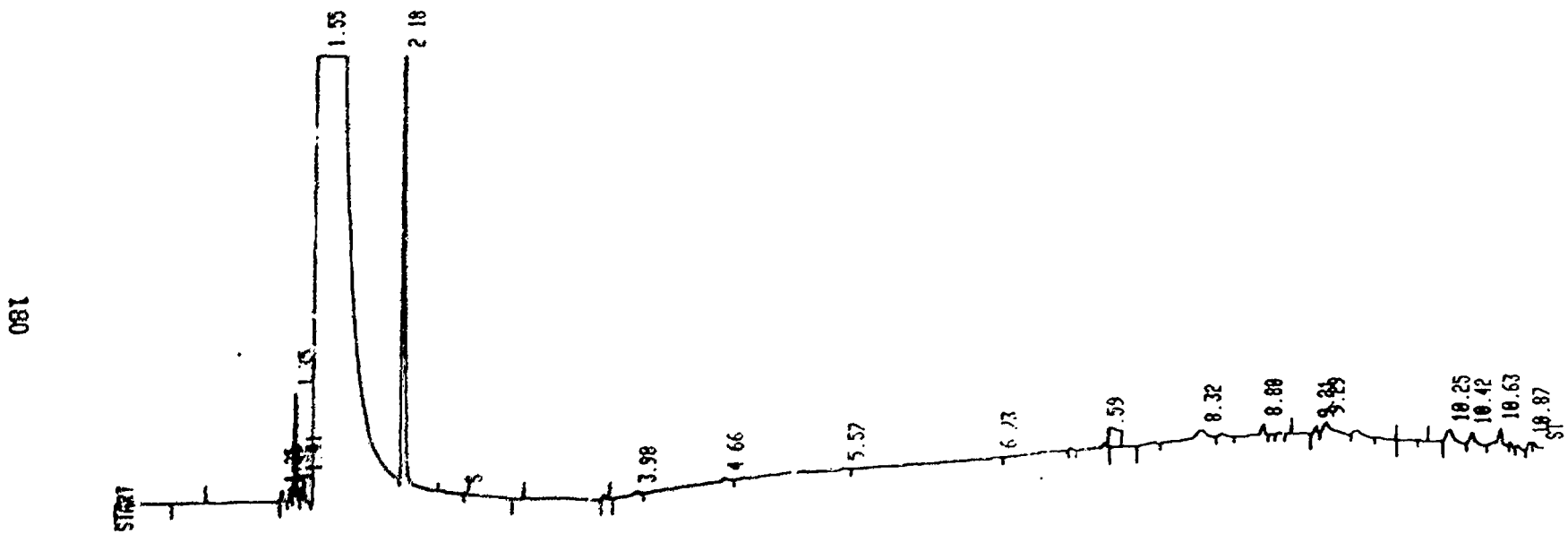

Figure H-5. Chromatogram of Sample 5 from HP 5890A Gas Chromatograph.

APPENDIX I

ASSIGNMENT OF PEAKS IN HALON 2402
GAS CHROMATOGRAPHY/MASS SPECTROMETRY STUDIES

The gas chromatography/mass spectrometry (GC/MS) of Halon 2402 from Italy (Montedison) is first examined and then the GC/MS of agent from Japan (Great Lakes Chemical Corporation).

The mass spectrum of the large total ion chromatographic peak, with its maximum at scan count 63 (Figure 34), confirms that it is due to Halon 2402, 1,2-dibromotetrafluoroethane (Figure I-1). Fragments containing bromine are readily identified owing to the presence of two bromine isotopes, ^{79}Br (50.54 percent natural abundance) and ^{81}Br (49.46 percent natural abundance). Naturally occurring fluorine is isotopically pure (^{19}F) and carbon is nearly so (^{12}C, natural abundance 98.89 percent; ^{13}C, natural abundance 1.11 percent). Fragments containing one bromine atom will give two peaks of nearly equal intensity separated by two mass units. Examples in Figure I-1 are provided by CF_2Br^+ with M/Z = 129 and 131, $C_2F_4Br^+$ with M/Z = 179 and 181, and $CBrF^+$ with M/Z = 110 and 112. Fragments containing two bromine atoms give rise to three peaks with an intensity ratio of approximately 1:2:1, each peak separated by two mass units. Figure I-1 shows such peak clusters centered at M/Z = 191 ($CFBr_2^+$), 241 ($C_2F_3Br_2^+$), and 259 ($C_2F_4Br_2^+$). That the last cluster, corresponding to the parent peak, is not centered at 260, as it should, indicates an instrument calibration error. No such error was detected for any other peaks in this study.

The mass spectrum of the chromatographic peak at scan number 49 (Figure 34) is shown in Figure I-2. The pair of mass peaks at M/Z = 129 and 131 clearly show the presence of the CF_2Br^+ fragment. The presence of the $C_2F_4Cl^+$ fragment is strongly indicated by the pair of peaks at M/Z = 135 and 137. Chlorine exists naturally as two isotopes, ^{35}Cl and ^{37}Cl with natural abundances of 75.53 percent and 24.47 percent. This gives fragments with relative mass intensities of approximately 3:1. Though the spectrum is not available in the computer library of the Finnigan GC/MS instrument, the spectral data indicate strongly that the peak at scan number 49 is due to $CBrF_2CClF_2$, 1-bromo-2-chlorotetrafluoroethane.

The mass spectrum of the component giving the very small total ion chromatograph peak at scan 53 shows an excellent match with the spectrum for CF_3Br, bromotrifluoromethane, found in the Finnigan library. A portion of the mass spectrum is shown in Figure I-3.

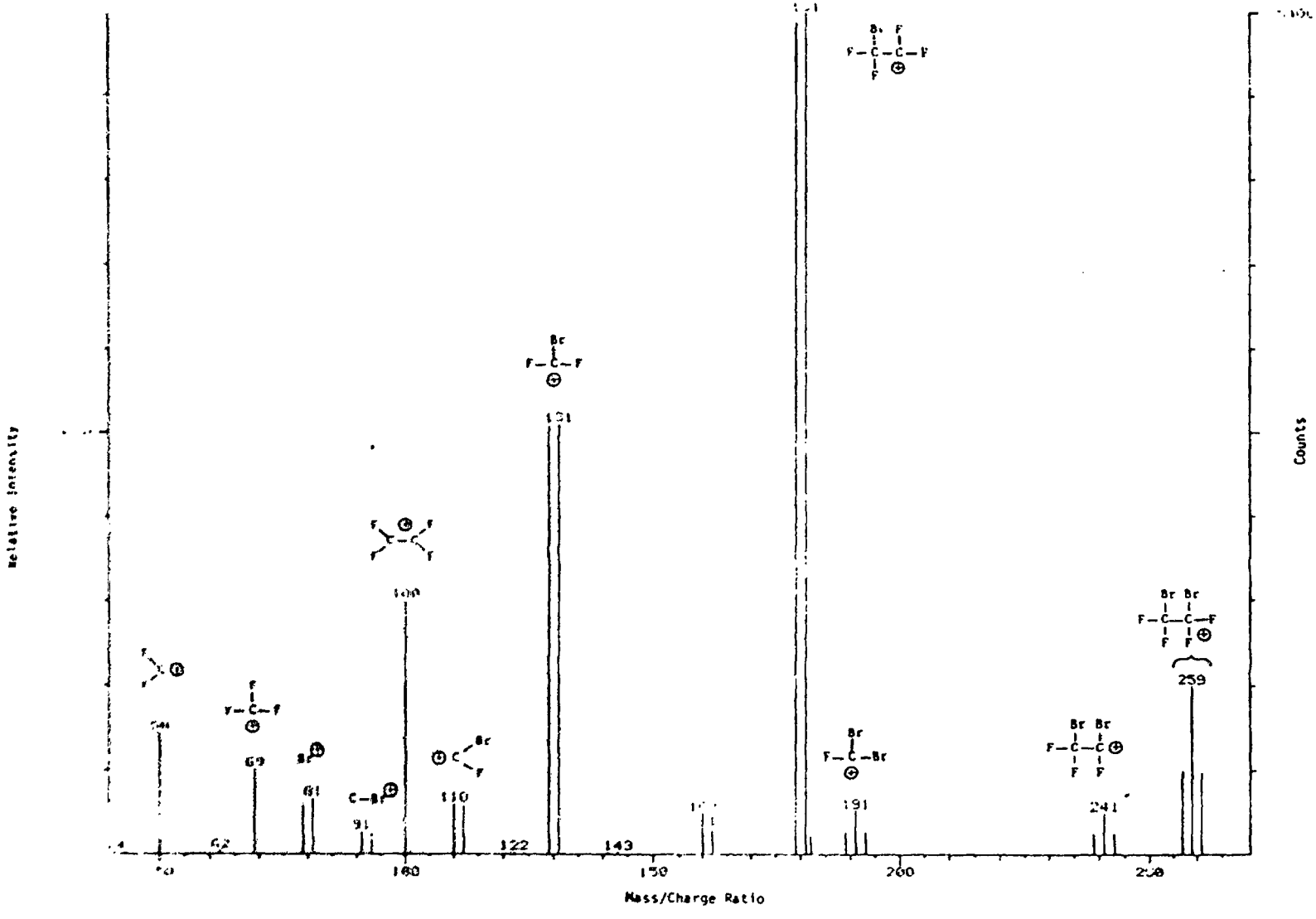

Figure I-1. Mass Spectrum of Halon 2402 Chromatographic Peak.

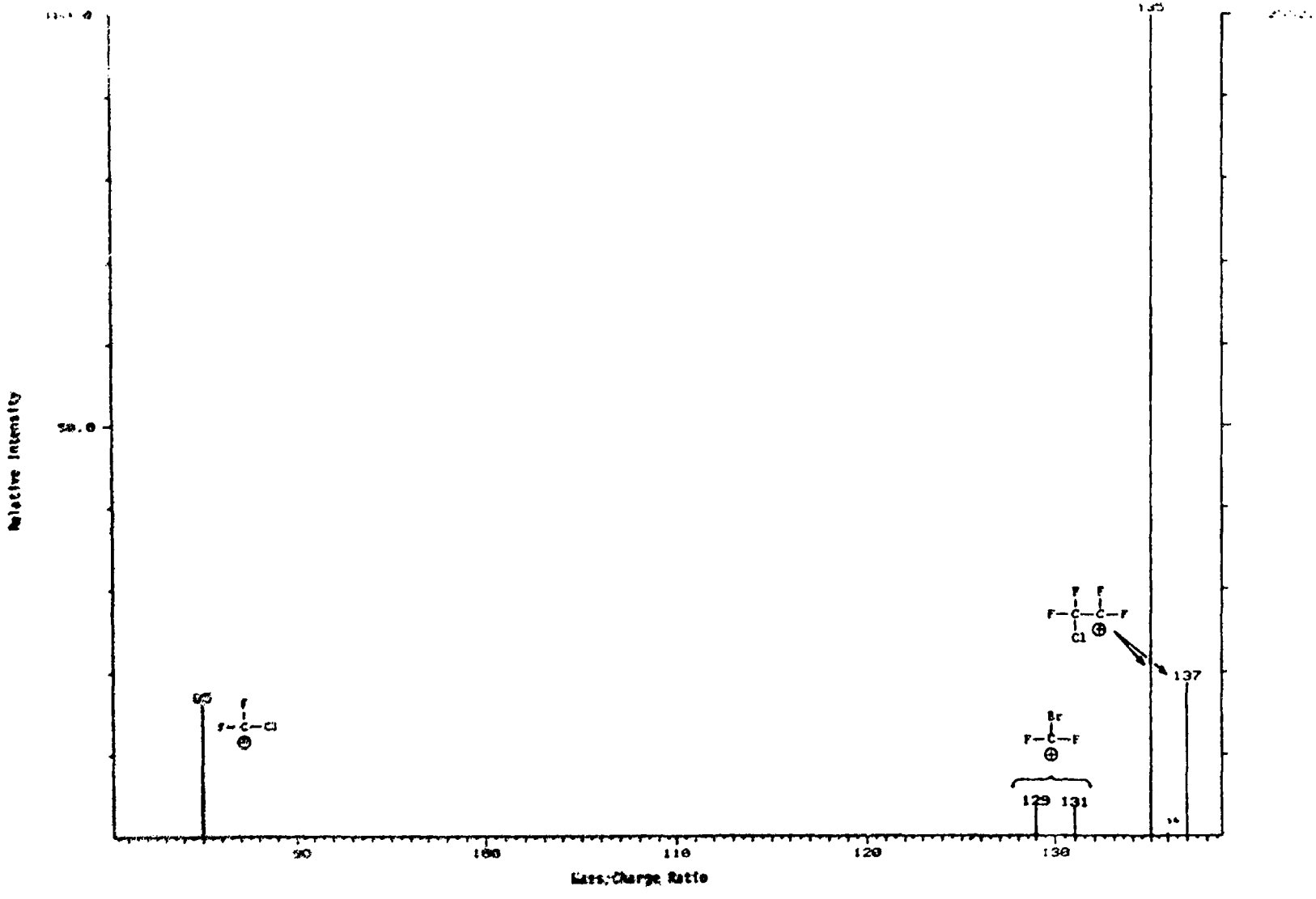

Figure I-2. Mass Spectrum of Component Assigned as $CBrF_2CClF_2$.

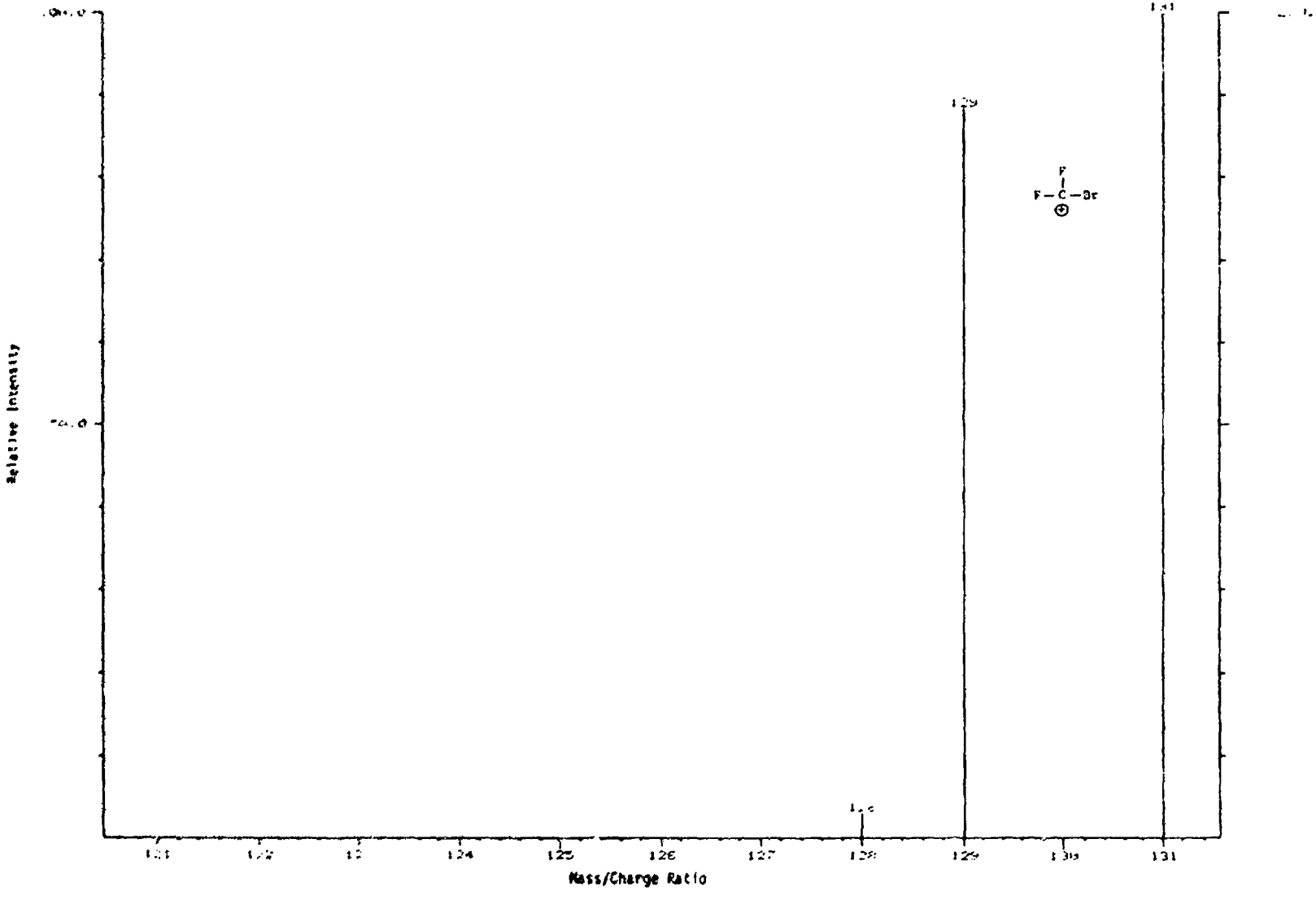

Figure I-3. Mass Spectrum of Component Assigned as CF_3Br.

The component giving rise to the total ion current chromatographic peak at scan 112 in Figure 34 cannot be unambiguously identified. The mass spectrum (Figure I-4) provides excellent evidence that the parent compound is a fluorinated 1-bromobutane; however, the parent peak is not observed. The mass peaks at M/Z = 279 and M/Z = 281 are almost certainly due to the loss of a single atom or group X from the compound, $CF_2BrCF_2CFXCF_3$; however, the mass spectrum gives no indication of what "X" is. Since the compound $CF_2BrCF_2CF_3$ has been identified in Halon 2402 (Reference I-1), this compound is a likely candidate for the impurity.

Figure 35 contains the total ion gas chromatogram of Halon 2402 supplied by Great Lakes Chemical Corporation (produced in Japan). Again the major peak due to Halon 2402 is split. The small total ion peak at scan 50 is unambiguously assigned as dibromodifluoromethane, CBr_2F_2 from the excellent spectral fit to the Finnigan GC/MS library (Purity = 930, Fit = 990, RFit = 936) and from the interpretation of the mass spectrum (Figure I-5). The spectrum shows a 1:2:1 triplet of peaks due to the parent ion and all expected dissociation products are observed. The small peak at M/Z = 135 is the only significant feature not explained.

The scan 171 chromatographic peak is assigned as dibromochloromethane, $CHBr_2Cl$ in a computer search of the Finnigan GC/MS library. The spectral match is good with purity = 871, Fit = 871, and RFit = 970. All significant peaks observed in the mass spectrum (Figure I-6) are assigned and the parent peak is observed. The unsymmetrical trio of peaks centered at M/Z = 129 is due to the presence of both chlorine and bromine in the same fragment.

The mass spectrum of the scan 210 component (Figure I-7) also gives an excellent identification from the Finnigan GC/MS spectral library as tribromomethane, $CHBr_3$ (Purity = 960, Fit = 960, RFit = 996). The parent peak is observed. With the exception of two small unidentified mass peaks at M/Z = 92 and 94, all peaks are accounted for. The small triplet of peaks centered at mass 160 is apparently due to formation of Br_2. Small peaks at 160 are observed in other spectra (Figures I-1, I-5).

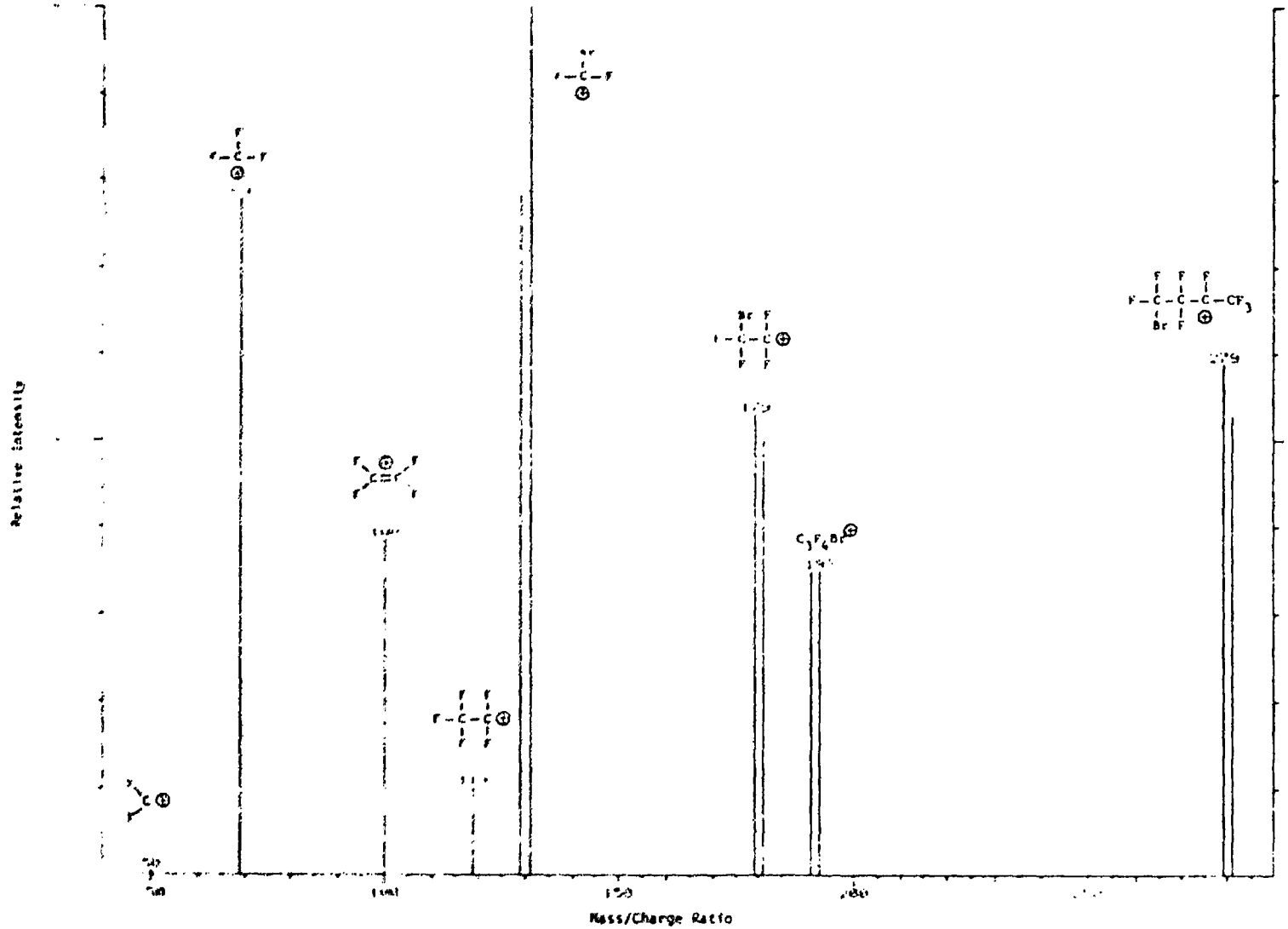

Figure I-4. Mass Spectrum of Component Assigned as $CF_2BrCF_2CFXCF_3$.

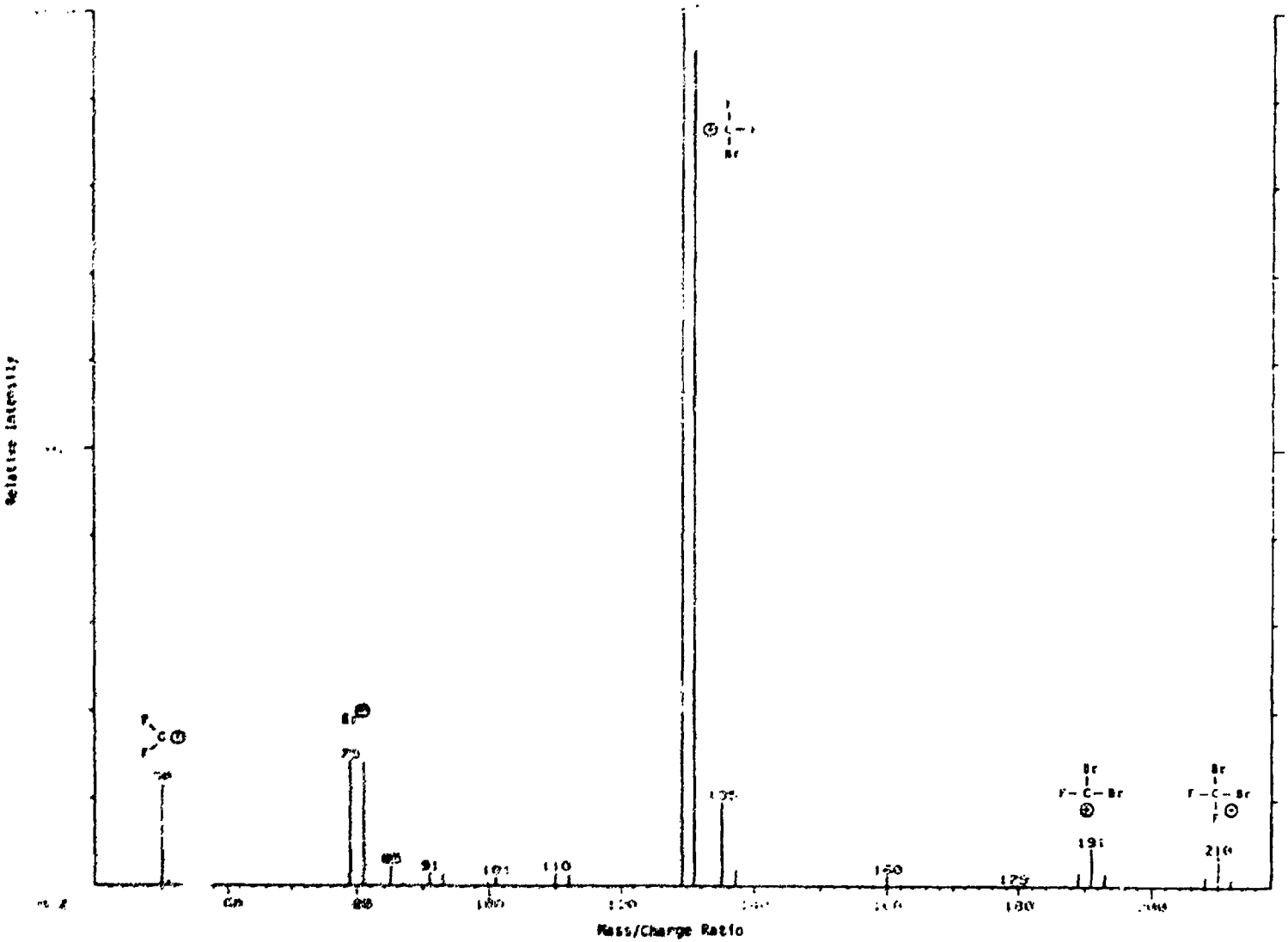

Figure I-5. Mass Spectrum of Component Assigned as CBr_2F_2.

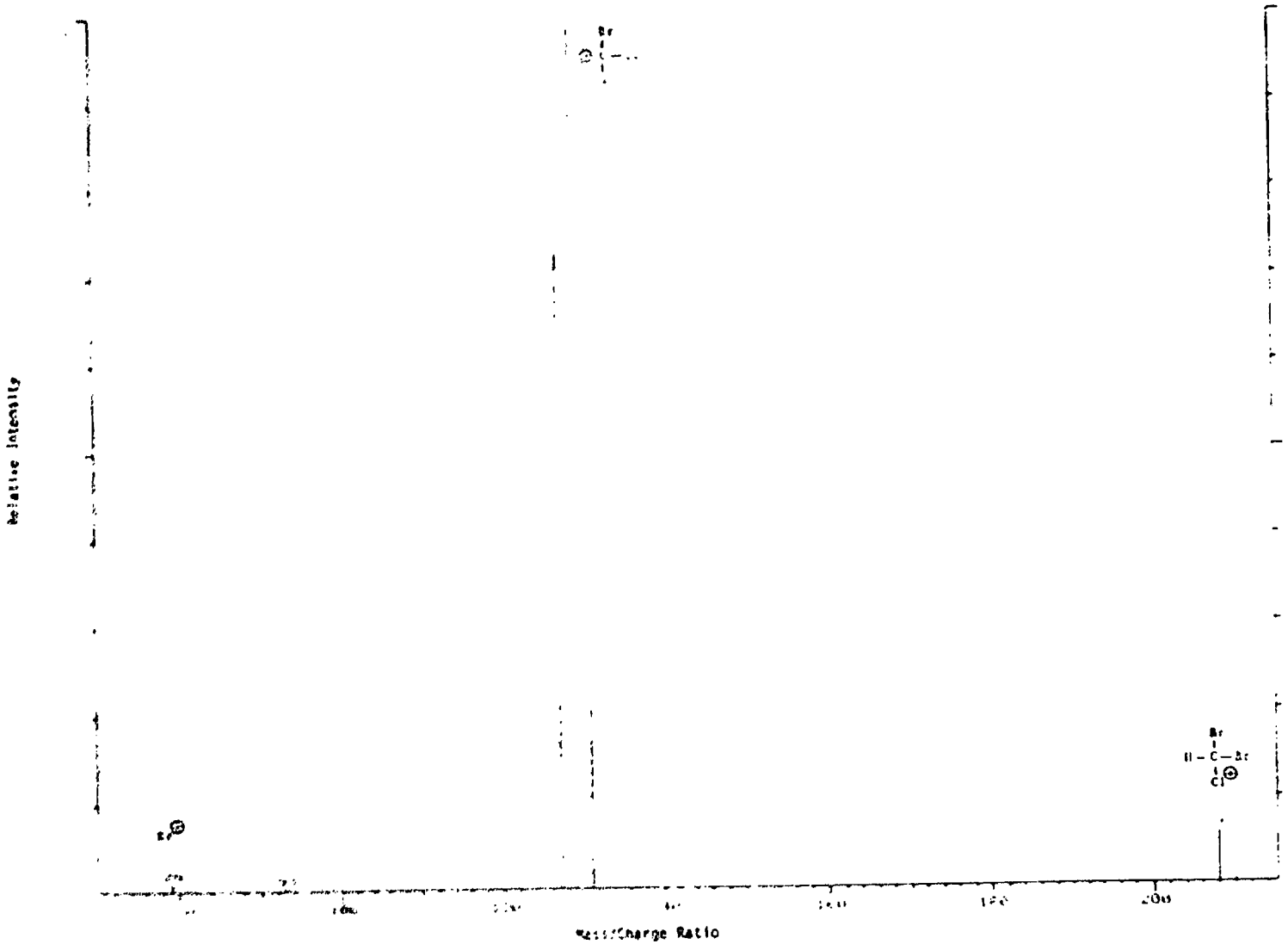

Figure I-6. Mass Spectrum of Component Assigned as $CHBr_2Cl$.

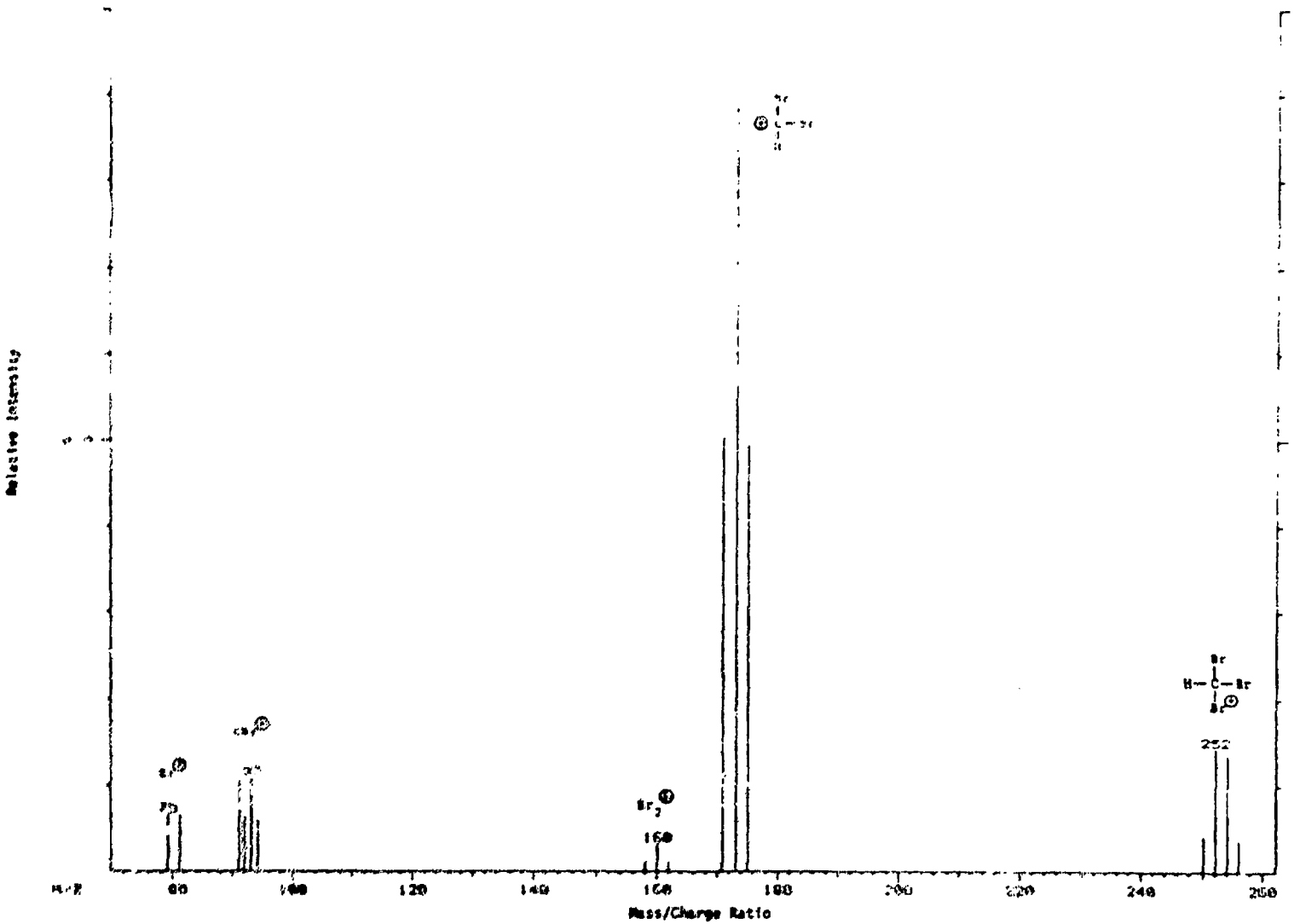

Figure 1-7. Mass Spectrum of Component Assigned as $CHBr_3$.

The remaining two peaks at scan 238 and scan 454 cannot be totally identified. The mass spectrum of the scan 238 chromatographic peak (Figure I-8) exhibits three peaks which are almost certainly due to the fragment CBr_2Cl and thus the parent compound is apparently $RCBr_2Cl$. Other ions are not detected owing to their low abundance. The chromatographic peak at scan 454 appears to be due to an amine of some type. The fragment pattern (Figure I-9) matches closely those observed for aliphatic amines (Reference I-2). The peaks at M/Z = 72, 58, 44 are probably due to $C_3H_7CHNH_2^+$, $C_2H_5CHNH_2^+$, and $CH_3CHNH_2^+$. The pair of peaks at M/Z = 123, 125 suggest a fragment containing a single bromine atom. It is likely that the fragment is $C_2H_4BrNH_3^+$. The peaks at M/Z = 81 ($^{81}Br^+$) and M/Z = 151 ($C_4H_8{}^{79}BrNH_2^+$ and/or $C_4H_7{}^{81}BrNH_2^+$) also indicate the presence of bromine; however, here some peaks owing to isotopes are missing (apparently due to low intensities). Thus, the spectrum strongly indicates that the component at scan 454 is a brominated aliphatic amine; however, the precise structure cannot be determined.

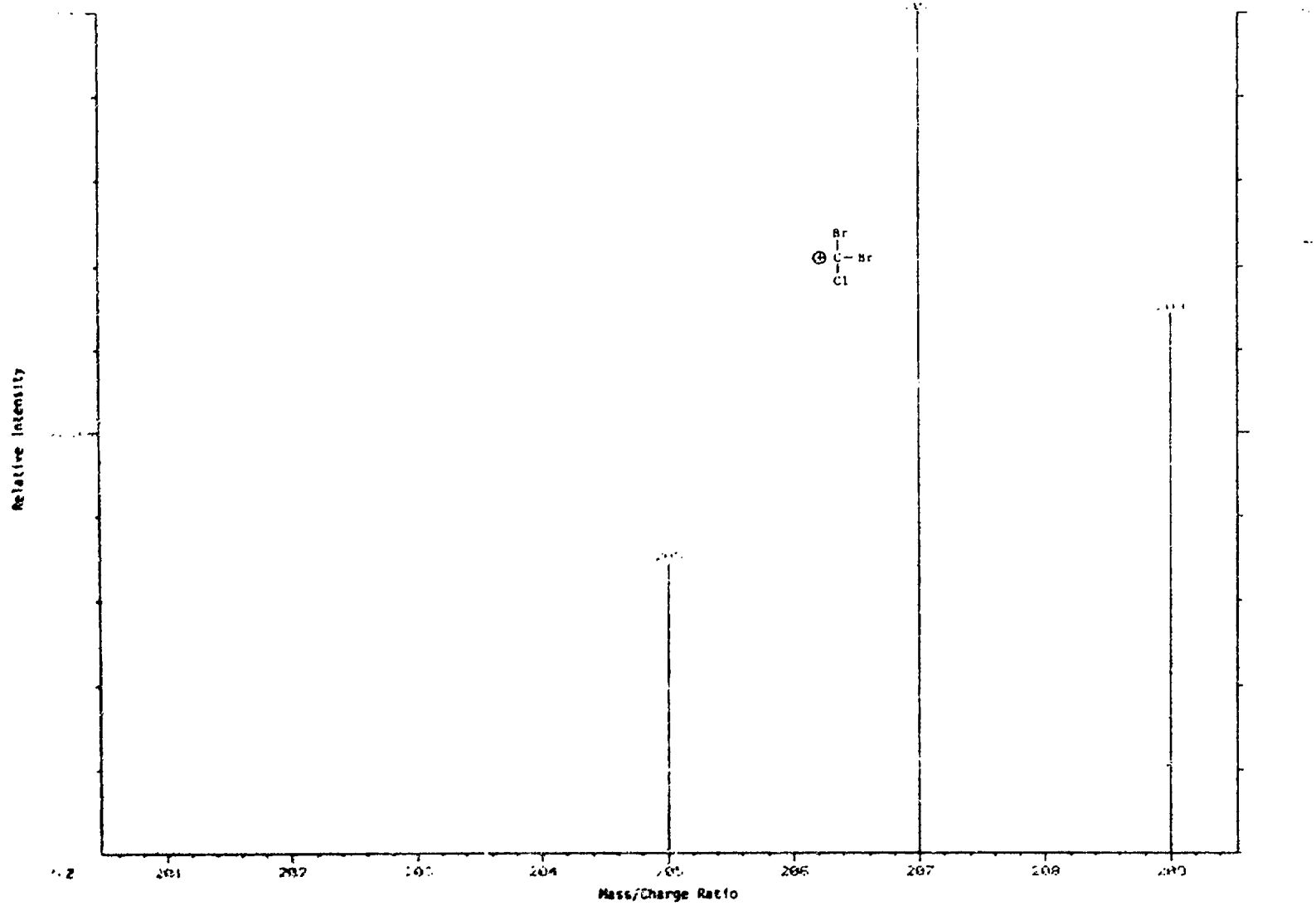

Figure I-8. Mass Spectrum of Component Tentatively Assigned as $RCFr_2Cl$.

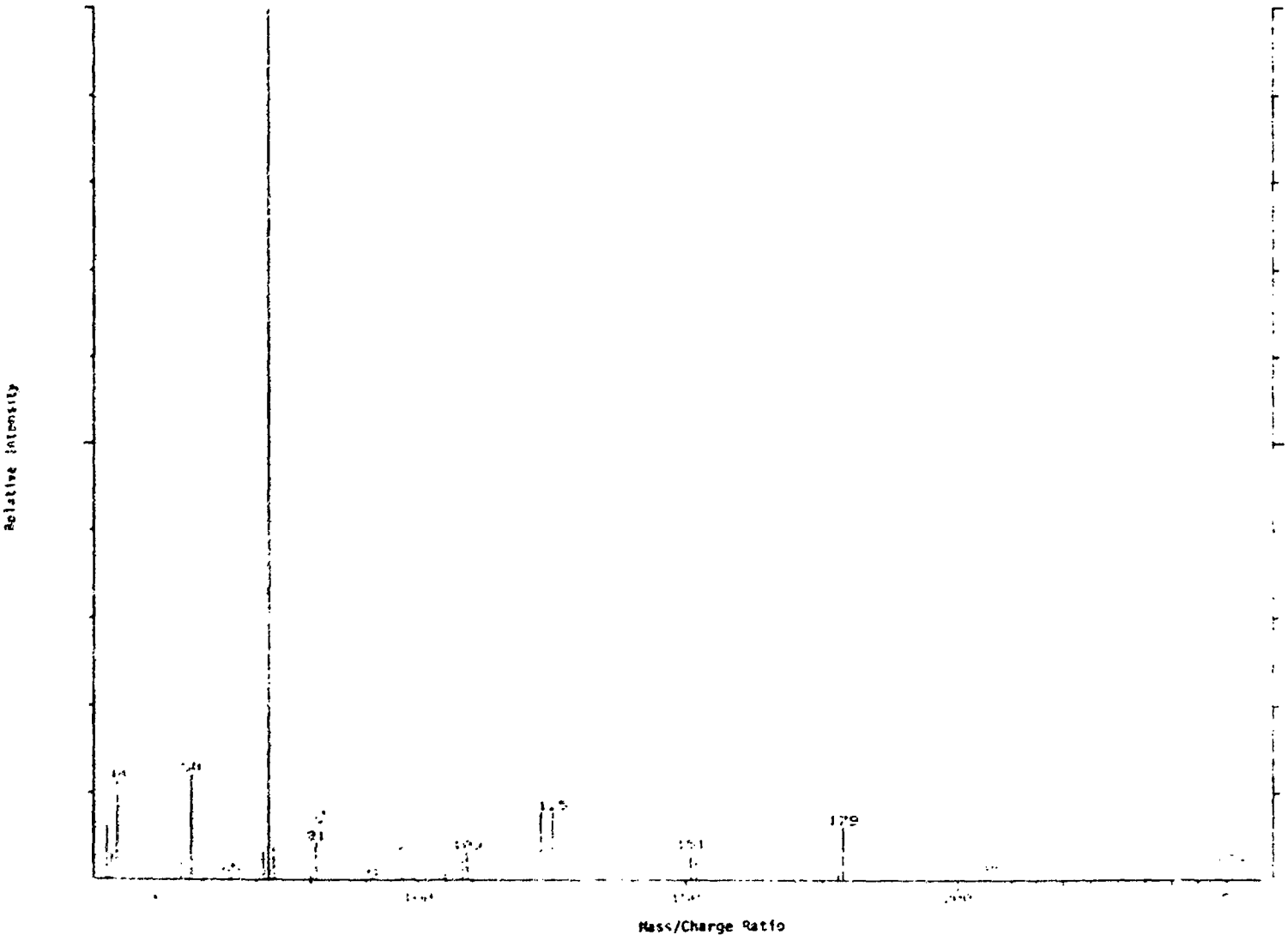

Figure I-9. Mass Spectrum of Component Tentatively Assigned as a Brominated Aliphatic Amine.

REFERENCES

I-1. Zallen, D. M., **Potential Hazards of Using Halons for Fuel Fires Involving Munitions**, Report ESL-R4TR-81-27, Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall Air Force Base, Florida, February 1981.

I-2. Silverstein, R. M., Bassler, G. C., Morrill, T. C., **Spectrometric Identification of Organic Compounds**, 3rd Ed., John Wiley & Sons, Inc., New York, 1974, p. 31.

APPENDIX J

PROPOSED DRAFT MILITARY SPECIFICATION FOR HALON 2402

DRAFT MILITARY SPECIFICATION

DIBROMOTETRAFLUOROETHANE

TECHNICAL GRADE FOR

FIRE EXTINGUISHER

1. SCOPE

1.1 This specification covers technical grade dibromotetrafluoroethan for use as a fire extinguishing agent.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on the date of invitation for bids form a part of this specification to the extent specified herein:

SPECIFICATIONS

FEDERAL

PPP-D-729 - Drums, Shipping and Storage, Steel, 55-Gallon (208.2-liters)

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-129 - Marking for Shipment and Storage

(Copies of specifications and standards required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D-1078 - Distillation Range of Volatile Organic Liquids.

D-1120 - Boiling Point of Engine Coolants.

D-2109 - Nonvolatile Matter in Halogenated Organic Solve and Their Admixtures.

D-2989 - Acidity-Alkalinity of Halogenated Organic Solvents and Their Admixtures.

D-3401 - Water in Halogenated Organic Solvents and Their Admixtures.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103).

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification Ratings, Rules, and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, Tariff Publications Officer, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

3. REQUIREMENTS

3.1 Description. The liquid dibromotetrafluoroethane shall be furnished in a container. The dibromotetrafluoroethane shall be technical grade with a minimum purity of 99.6 percent and shall conform to the requirements of Table I when tested with the applicable method.

TABLE I. REQUIREMENTS FOR DIBROMOTETRAFLUOROETHANE.

Property	Requirement	Test paragraph
$C_2F_4Br_2$, mole percent, minimum	99.6	4.6.1
Acidity ppm HBr (by weight), maximum	3.0	4.6.2
Free halogen ppm bromine (by weight) maximum	15.0	4.6.3
Water content, ppm (by weight), maximum	20.0	4.6.4
Boiling point, °C at 760 mm Hg	46.7	4.6.5
Boiling range, °C, 5 to 85 percent distilled	3	4.6.6
Nonvolatile impurities, ppm (by weight), maximum	50	4.6.7
Suspended matter or sediment	None visible	4.6.8

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Component and material inspection. The contractor is responsible for ensuring that components and materials used are manufactured, examined, and tested in accordance with reference specifications and standards as applicable.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) Quality conformance inspection (see 4.4).

(b) Inspection of packaging (see 4.5).

4.3 Sampling.

4.3.1 Lot. A lot shall consist of all dibromotetrafluoroethane manufactured as one batch and offered for delivery at one time. A batch shall be that quantity of the dibromotetrafluoroethane manufactured at one time.

4.3.2 Sampling for inspection of filled containers. A random sample of filled containers shall be selected from each lot in accordance with MIL-STD-105, Level I, with an acceptance level (AQL) of 2.5 percent defective when inspected as specified in 4.5.

4.3.3 Sampling for quality conformance inspection. From each lot of filled containers not less than three containers shall be taken at random for the tests described in 4.6. The containers may be returned to the lot after acceptance.

4.4 Quality conformance inspection. The samples selected in accordance with 4.4.3 shall be subjected to the quality conformance inspection test described in 4.6. If the sample tested is found to be not in conformance with any of the quality conformance tests, the lot represented by the sample shall be rejected.

4.5 Examination of filled containers. Each sample filled container shall be examined for defects of construction of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each filled container shall also be weighed to determine the amount of contents. Any container in the sample, having one or more defects or less than required fill, shall not be offered for delivery; and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, this shall be cause for rejection of the lot represented by the sample.

4.6 Test methods.

4.6.1 Assay. The percentage of dibromotetrafluoroethane shall be determined by gas-liquid chromatography. The components of the sample are separated and the area of each peak is measured. The dibromotetrafluoroethane content of the sample is found in comparing the area of its peak with the total area of all the components.

4.6.1.1 Apparatus. The following special apparatus is required to determine the percentage of monobromotrifluoromethane:

(a) Gas chromatograph, equipped with a 1-mv recorder and a flamev ionization detector (FID).

(b) Column: 25-meter long, 0.2 mm diameter, 5-percent phenyl 9 percent methyl silicone WCOT capillary column, or equivalent.

4.6.1.2 Reagents. The carrier gas shall be a high purity grade of helium.

4.6.1.3 Procedure.

(a) Follow the instrument manual and column preparation directions for instructions on column installation and preparation.

(b) Install the column and adjust the temperature of the column oven to 30 °C, the injection port to 200 °C, and the detector block to 250 °C. Temperature should be programmed to hold 30 °C for 3 minutes and then ramp at 20 °C/min to 150 °C and hold at 150 °C for 2 minutes.

(c) Adjust the helium flow to 1 mL/min, increased to 30 mL/min with makeup gas. The hydrogen and airflow rates to the FID should be set to 30 mL/min and 450 mL/min, respectively. A septum purge of 4 mL/min and a split vent of 100 mL/min (split ratio, 100:1) should be employed.

(d) At least three 2 µL aliquots of each sample should be analyzed.

4.6.1.4 Calculations. The percent of dibromotetrafluoroethane shall be calculated as follows:

$$\% \ C_2F_4Br_2 = \frac{A_h}{A_s} \times 100$$

where: A_h = area of dibromotetrafluoroethane peak, and A_s peak heights.

Dibromotetrafluoroethane percent less than the amount specified in Table I shall constitute failure of this test.

4.6.2 Acid halides. The amount of acid halides present in a sample of dibromotetrafluoroethane shall be determined in accordance with ASTM D-2989.

4.6.2.1 Calculations. The ppm acid halides, as HBr, shall be calculated as follows:

$$\text{ppm acid halides} = \frac{V \times N \ NaOH \times 0.0809 \times 10^6}{\text{weight of sample (grams)}}$$

where V = ml NaOH for sample.

Acid halides in excess of the amount specified in Table I shall constitute failure of this test.

4.6.3 Free halogen. The amount of free halogen present shall be determined by liberation of iodine followed by titration with sodium thiosulfate solution.

4.6.3.1 Reagents.

(a) Sodium thiosulfate, 0.01 N solution: prepare a 0.1 N solution by dissolving 25 grams of sodium thiosulfate ($Na_2S_2O_3.5H_2O$) and 0.5 grams of sodium carbonate in one liter of distilled water. Standardize against 0.1 N potassium dichromate solution. From this 0.1 N solution of sodium thiosulfate, prepare a 0.01 N solution: pipet a 10 mL aliquot of the standard 0.1 N sodium thiosulfate solution into a 100 mL volumetric flask, fill to the mark with distilled water and mix. Prepare the 0.01 N sodium thiosulfate solution fresh daily.

(b) Sulfuric acid, 1:4 solution in water.

(c) Potassium iodide, 10 percent solution in water.

(d) Starch indicator.

4.6.3.2 Procedure. Pour 100 mL of 10 percent potassium iodide solution into a 250 mL Erlenmeyer flask. Add 10 mL of 1:4 sulfuric acid and 1 mL of starch solution. Bubble 100 grams of dibromotetrafluoroethane vapor through the potassium iodide solution in a fume hood. Titrate any liberated iodine with the standard 0.01N sodium thiosulfate solution. Run a reagent blank along with the sample.

4.6.3.3 Calculation. The ppm of free halogen, as bromine, shall be calculated as follows:

$$\text{ppm free halogen (as Br)} = \frac{(A + B) \times N\ Na_2S_2O_3 \times 0.0799 \times 10^6}{\text{weight of sample in grams}}$$

Where ml of $Na_2S_2O_3$ for the sample, and ml of $Na_2S_2O_3$ for the blank.

4.6.4 Water content. The analysis may be conducted by the phosphorus pentoxide method, by infrared absorption, by an electrolytic moisture analysis, or by a piezoelectric analyzer. The accuracy of the results and the standard method shall be the Karl Fischer method in accordance with ASTM D-1744.

4.6.5 Boiling point. The boiling point of dibromotetrafluoroethane shall be determined in accordance to ASTM D-1120, except that the cooling water for the condenser shall be maintained at 5 ± 3 °C through the use of a constant temperature bath.

4.6.6 Boiling range. The boiling range shall be determined on a 100 mL sample in accordance with ASTM D-1078, except that the distillation rate shall be between 1 and 2 mL per minute.

4.6.7 Nonvolatile impurities. The amount of nonvolatile impurities in a sample of dibromotetrafluoroethane shall be determined in accordance with Method A of ASTM D-2109.

4.6.8 Suspended matter and sediment. Examine visually for any suspended matter or sediment. Observation of any suspended matter or sediment shall constitute failure of this test.

5. PREPARATION FOR DELIVERY

5.1 Packaging. The level of packing shall be Level A. 660 + 6 - 0 pounds (299.38 + 2.72 - 0 kilograms) of dibromotetrafluoroethane (this corresponds to a maximum fill of 70 percent) shall be packaged in a 55-gallon (208.2-liter) drum conforming to Type I, Class A of PPP-D-729. The closure shall be furnished with gaskets as specified in PPP-D-729. Gaskets shall be formed from material fabricated from polyethylene. The drum shall be closed by tightening the 3/4-inch (19.05-millimeter) plug to a torque of 15 to 17 pound-feet (20.3 to 23.0 Newton-meters) and by tightening the 2-inch (50.8-millimeter) plug to a torque of 30 to 33 pound-feet (40.7 to 44.7 Newton-meters). There shall be no evidence of leakage of contents when the filled drum is tested as specified in 4.5.

5.2 Packing. Dibromotetrafluoroethane packaged as specified in 5.1 shall require no overpacking.

5.2.1 Method of shipment shall comply with Uniform Freight Classification Ratings, Rules, and Regulations of other carrier rules as applicable to the mode of transportation.

5.3 Marking. Containers shall be marked in accordance with MIL-STD-129. The shipment marking shall be as follows: "Dibromotetrafluoroethane, Technical; MIL-D-XXXX."

5.3.1 Precautionary marking. All individual containers shall be marked with the following precautionary information:

Warning vapor harmful.

Use only with adequate ventilation.

Avoid prolonged breathing of vapor.

Avoid prolonged or repeated contact with skin.

Do not take internally.

Store in cool place (not over 100 °F).

6. NOTES

6.1 Intended use. The dibromotetrafluoroethane covered by this specification is intended for use as a specialized fire extinguisher fluid.

6.2 Ordering data. Procurement documents should specify the following: title, number, and date of this specification.

6.3 Dibromotetrafluoroethane will be purchased by weight, the unit being an avoirdupois pound.